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VERTICAL LIMBAL OR OBLIQUE EXTRALIMBAL INCISION FOR IRIDENCLEISIS IN GLAUCOMA

THE EFFICIENCY OF IRIDECTOMIES BEFORE 1884

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When I sent my paper, "Histology of Fistulas Following Anterior Sclerectomy," [1] to the ARCHIVES in March, 1931, the March number of *Archives d'ophtalmologie* [2] had not yet reached the University Eye Clinic in Oslo. I had not had an opportunity to read it until I received a reprint of the quoted article [2] from Professor Weekers two months later. The authors, who repeatedly said that I had performed iridencleisis only for chronic glaucoma, could not have read my article in 1927 on iridencleisis for acute glaucoma,[3] although that article is the first one quoted in their references.

Weekers and Hubin evidently make the section from the outside with a knife (figs. 1 and 2), as suggested by Lundsgaard [4] for iridencleisis. They do not employ the "limbal flap" (a loosening of the conjunctiva at the periphery of the cornea, suggested by Dupuy-Dutemps for the Elliot operation in 1913), the technic used by Lundsgaard in his earlier work.[4] They make—as did also Lundsgaard later—a broad conjunctival flap (fig. 1), prepared with a pair of scissors, just as in anterior sclerectomy (Holth, 1909; Elliot, 1918). In figure 2 the periphery of the cornea is drawn somewhat thinner than the more central part (the opposite of the natural condition), and the bulbar conjunctiva appears much thicker than normal. A subconjunctival iris inclusion in the vertical section of figure 2 must, according to figure 1, be situated close underneath the limbal epithelium.

Weekers and Hubin obtained immediate normal and later subnormal tension in fifteen cases of acute and eighteen cases of chronic primary glaucoma. In ten cases of secondary glaucoma, however, the tension

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From the discussion on the operative treatment for glaucoma at the Eighth Northern Ophthalmological Congress, Helsingfors, Finland, June 25, 1931.

1. Holth, S.: Histology of Fistulas Following Anterior Sclerectomy, Arch. Ophth. **6**:151 (Aug.) 1931.

2. Weekers, L., and Hubin, R.: Résultats obtenus par l'enclavement de l'iris dans le glaucome, Arch. d'opht. **48**:186 (March) 1931.

3. Holth, S.: Iridencleisis cum Iridotomia meridionali bei Glaucoma acutum, Klin. Monatsbl. f. Augenh. **79**:620, 1927.

4. Lundsgaard, K. K. K.: On the Indications for a Corneal Section from the Outside with a Knife and the Technique of the Operation, Acta ophth. **6**:311, 1928.

was not lowered, or very little, as I reported in 1907.[5] In these secondary glaucomas, especially uveitic, I have performed mainly the classic iridectomy for quite a long time.

To the inclusion of the iris in the vertical limbal incision I am obliged to raise the following objections: (*a*) The conjunctical flap is too large and causes a large area of subconjunctival scar tissue. (*b*) The iris lies under the thinnest portion of the limbal conjunctiva—almost immediately under the epithelium.[6] (*c*) The scars are described as "cystoid," an undesirable form, which is unavoidable, when the authors—as they often do—neglect to perform meridional iridotomy.

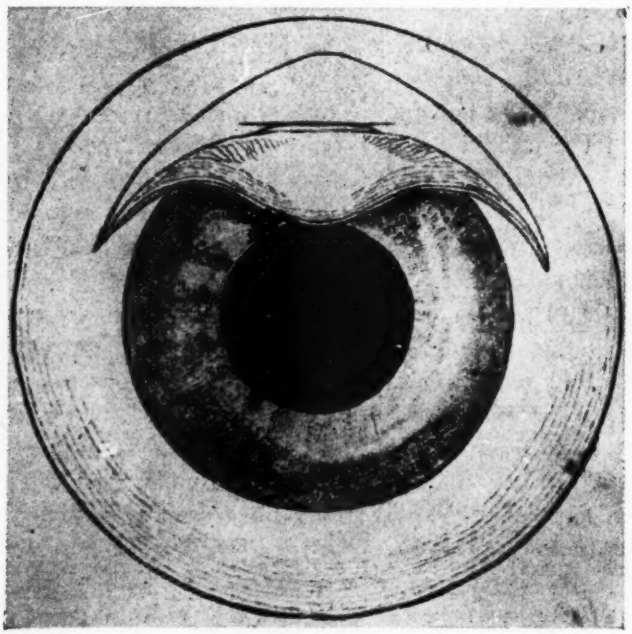

Fig. 1.—Diagram showing front view of Lundsgaard and Weekers' vertical scleral section from the outside, close to the transparent limbus corneae (from Weekers and Hubin: Arch. d'opht. **48**:186 [March] 1931, fig. 2).

(*d*) Some time after the operation, a subnormal tension develops which, to my mind, is not to be desired.

Lundsgaard and Weeker's vertical scleral section close to the transparent limbus corneae is undoubtedly easier to perform than the 4 mm. oblique section with a lancet in acute glaucoma with a very shallow

5. Holth, S.: Ann. d'ocul. **137**:345, 1907.

6. The same is the case in the operation of R. Denig (Ueber Irisfistel bei Glaukom, Arch. f. Ophth. **125**:156, 1930), who combines anterior sclerectomy with iridencleisis, both according to a technic that deserves no imitation. I suggested[1] the same combination in 1912 and later gave it up.

anterior chamber;[7] but through a vertical section it would be better not to perform an iridencleisis, but rather, like Gayet in 1884, to employ an ordinary iridectomy.

All forms of anterior sclerectomy require a larger conjunctival flap, which produces an extended area of subconjunctival scar tissue, difficult subconjunctival drainage, often fistulization outward (Seidel) and sometimes late infection.

My inclusion of the iris in the oblique incision made through the subconjunctival tunnel with a lancet has the following merits: 1. It produces the smallest possible area of subconjunctival scar tissue, accordingly less resistance against subconjunctival drainage of the aqueous, and, extremely seldom, fistulization outward (Seidel's test is

Fig. 2.—Diagram of the vertical incision in figure 1 (from Weekers and Hubin, fig. 3), in sagittal direction.

nearly always negative). 2. The anterior superficial valvelet covers the iris, enclosed in the oblique incision and protects it better than does the isolated conjunctiva; this holds also for acute glaucoma when the oblique incision is close to the limbus, because the distal opening of the iris fistula comes more to the periphery than the section. In chronic glaucoma, when the oblique incision may be laid more or less extralimbally, the distal opening of the iris fistula may be 2 or 3 mm. distant from the limbus corneae. 3. The posterior deep valvelet protects the ciliary body against injury. 4. The method prevents a sudden

7. Holth, S.: (*a*) Iridencleisis cum Iridotomia Meridionali; An Operative Method Both in Acute and in Chronic Primary Glaucoma, Arch. Ophth. **4**:803 (Dec.) 1930; (*b*) footnote 3.

fall of tension, which in most cases will be from 15 to 25 mm. of mercury. 5. It is the safest prophylactic against an expulsive hemorrhage.

I said in Helsingfors [8] (because I believed it was so done at the University Eye Clinic in Oslo) that iridencleisis may also be performed with a small conjunctival flap made with scissors; this is not the case. Prof. Sigurd Hagen is, like Dr. Harald Gjessing, a convinced partisan of my "subconjunctival tunnel," made simultaneously with the lancet.

Professor Hagen lets the assistant hold an anatomic fine forceps or Stevens' tenotomy hook and draw the proximal lip of the conjunctival incision almost to the limbus. During the meridional iridotomy he does not loosen his grasp of the iris with the forceps (as I myself never did before the retrobulbar anesthesia of Duverger in 1920), and the meridional cut is made in the lateral (preferably the nasal) part of the iris tent. The nasal leg of the coloboma retracts nearly completely; then a larger iridencleisis is made of the temporal leg of the coloboma, as efficient as any two central ones, which require my double conjunctival retractor in the assistant's hand.

In a previous article [7a] I said, regarding the technic, that the instruments should be placed for thirty minutes in dry heat (155 C. or 311 F.); this should be corrected to 160 C. or 320 F. for thirty full minutes. In this way, all living microbes, including the spores of earth bacilli and the tetanus and anthrax bacilli are killed without any damage to the cutting edges; these effects are not obtained in boiling water a single time.

Pilocarpine or physostigmine should not be instilled the last twelve hours before iridencleisis in order to prevent retraction of the included iris after the operation; by retrobulbar anesthesia, using 2 cc. of procaine hydrochloride (4 per cent) with 2 drops of epinephrine, the tension is sufficiently lowered.

The instillation of atropine,[9] this valuable prophylactic against the "quiet iritis" after Elliot's operation, is absolutely contraindicated after iridencleisis, after which operation any traces of iritis are rare; here I make a few instillations of homatropine hydrobromide (1 per cent), which I never have seen increase the tension in such cases. It is true that a single posterior synechia or two may be seen years later; they are of no moment. After iridencleisis in primary glaucoma I have never seen precipitates on Descemet's membrane; cyclitis is nowadays to be excluded by biomicroscopy before the operation.

8. Holth, S.: Acta ophth. **10**:5, 1932.

9. Wright, R. E.: Report of the Government Ophthalmological Hospital, Madras, for the Year 1931, Madras, 1932, p. 10.

Ernst Adolf Coccius (1825-1890) [10] first described the filtering scar after iridectomy in glaucoma and really understood the importance of the inclusion of the iris in the limbal incision: "(in chronic glaucoma) the results of iridectomy (with following paracenteses) cannot compare with those yielded by iridencleisis, and the point is not to excise a large piece of iris, but only to let a larger piece of iris stay in the incision. . . . The thin iris can drain the aqueous in larger quantity than can possibly be done through the cornea." Von Graefe [11] did not accept this proposition. In case of failure after the first iridectomy a second broad one should be made in the opposite direction. However, the phrase "filtering scar" was first used by L. de Wecker (1867-1871) as a theoretical explanation of his own operation *sclérotomie antérieure,* always *sans enclavement de l'iris* [without inclusion of the iris]. In 1901 he considered the operation only as preparatory; [12] the iridectomy had to be added later. In the discussion neither de Wecker nor the debaters mentioned the importance of the inclusion of the iris in the incision, a single author, Dr. Parinaud excepted. In iridectomy for chronic glaucoma, Parinaud made use of his experiences with the hardly avoidable inclusions of the iris in the wound during cataract extraction through von Graefe's modified linear incision. He made an extralimbal incision with the lancet or the linear cataract knife and then a central excision of the iris, which was left untouched in the angles of the wound, a point of the greatest importance for the obtaining of an "ectatic" or a "filtering" scar. Bader [13] allowed the iris to prolapse without excision underneath the conjunctiva through an extralimbal sclerotomy, while Herbert,[14] like Coccius and Parinaud, excised the central part of the prolapsed iris.

The new features of my "iridencleisis antiglaucomatosa" are: (1) my replacement of the excision of the iris with an "incision," whereby none of the fistula-forming material is lost (best done with the meridional iridotomy [1905]), and (2) my "subconjunctival tunnel" (January, 1905), which reduces the production of subconjunctival scar tissue to a minimum.

Further, through systematic histologic examination of glaucomatous eyes post mortem in ten cases, I have demonstrated the subconjunctival iris fistula up to six years after the iridencleisis.

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10. Coccius, E. A.: Ueber Glaukom, Entzündung und die Autopsie mit dem Augenspiegel, Leipzig, A. Edelmann, 1859, p. 18.

11. von Graefe: Arch. f. Ophth. **6**:151, 1859, footnote.

12. Parinaud, H., in discussion on de Wecker, L.: Valeur de l'iridectomie dans le glaucome, Ann. d'ocul. **125**:438, 1901.

13. Bader, C.: Sclerotomy in Glaucoma, Tr. Internat. M. Cong., London, 1881, vol. 3, p. 98.

14. Herbert, H.: Subconjunctival Fistula Formation in the Treatment of Primary Chronic Glaucoma, Tr. Ophth. Soc. U. Kingdom **23**:324, 1903.

After anterior sclerectomy with the punch forceps or trephine I have shown that the wandering of endothelial cells from Descemet's membrane into the scleral defect may play some part in the holding open of the latter, but that a spontaneous but uncertain wandering of the isolated pigment epithelium from the iris into the defect is considerably better. Inclusion of the whole thickness of the iris in the sclerectomy defect, however, is dangerous.

Several times after both iridencleisis and anterior sclerectomy I have observed the inconstant ophthalmoscopic flattening of the glaucomatous excavation of the papilla, as seen by von Graefe and later verified by Axenfeld after successful iridectomies. I have also demonstrated this in microscopic sections post mortem. In one case of *glaucoma fere absolutum* the excavation, 4 diopters deep, was reduced so that it was filled with glial tissue in which the central vessels were lifted up on a level with the retina, while the lamina cribrosa was still excavated.[15]

In Helsingfors on June 25, 1931, I projected a horizontal axial section through a glaucomatous papilla, in which the temporal excavation was completely flattened, the lamina cribrosa included; the excavation to the margin, 1.5 diopters deep, was visible with the Morton ophthalmoscope before my anterior sclerectomy with punch forceps.[8]

I do not doubt that the therapeutic value of the iridectomy in chronic glaucoma was greater before 1884 than after, when the introduction of local anesthesia with cocaine greatly helped to replace the iris included in the angles of the incision. Statistical proof of this undesirable effect of the introduction of cocaine in 1884 can, however, hardly be made retrospectively. Seventeen years later [12] this question was not discussed, even by Parinaud.

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15. Holth, S.: Ber. d. ophth. Gesellsch., Heidelberg, 1913, p. 366, fig. 10.

THE MACHEK OPERATION FOR PTOSIS

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Ptosis is a not uncommon condition which often demands relief, not only for cosmetic reasons, but in many cases, to permit vision without extreme tilting of the head. The number of operations that have been proposed (fifty-five were described by Elschnig [1]) is evidence that none has given uniformly satisfactory results. A satisfactory description of the various types of operation employed is that of Lancaster.[2] Such operations may be divided into three groups, according to the mechanisms involved. One group, of which the operation of Eversbusch is best known, attempts to shorten or advance the levator, usually with resection of a portion of the tarsus. Such operations are suitable only for partial ptosis, usually of slight degree, in which the levator is active. A second group, including the operation of Parinaud and its more generally accepted modification by Motais, unites part of the superior rectus with the upper lid. This allows the lid to be raised when looking up, but often leaves the palpebral fissure insufficiently wide for good cosmetic effect. Motais completed it in such cases by later excision of a strip of lid, including the tarsus. Because of Bell's phenomenon, the tendency of the upper lid to remain open during sleep involves an especial danger of keratitis, which occurred in 15 per cent of Motais' cases. The modification of Kirby, who performed the operation through a skin incision, simplifies the procedure, but is open to the same objections. The operation can be employed only in patients with a functioning superior rectus, which excludes many cases of congenital ptosis with absence of upward ocular movement, and also cases consequent on third nerve paralysis.

The third group of operations attempts a more intimate connection between the upper lid and the frontalis muscle, so that a minimal contraction of this muscle will raise the lid. Such connections have been made by stitches (type Hess) skin flaps (type Panas) or free grafts of tissue such as fascia lata (Lexer, Lancaster, Blair). These are applicable to any type of ptosis, but some of them involve unnecessary deformity

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1. Elschnig, in Graefe-Saemisch: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, Wilhelm Engelmann, 1922, p. 249.

2. Lancaster: Tr. Am. Acad. Ophth. **24**:235, 1919.

of the lid owing to the removal of too much skin, the normal fold in the upper lid being then absent, while some have proved less effective than others. The use of fascia lata, while giving excellent results in the hands of such plastic surgeons as Blair, involves a rather laborious operation to obtain the fascia and requires that the patient remain in bed for at least a week to avoid hernia of the muscle through the fascial wound.

It is not my intention to review the various operations of this third type, but to describe one of them, proposed in 1914 by Machek [3] of Lemberg, which has given excellent results in my experience. This is based on the observation of numerous operations performed by H. Gifford and of eighteen personal cases. Five patients (nine eyes) were operated on during the past year at the Northwestern University Eye Clinic. This description is undertaken because the operation seems to have been insufficiently appreciated. Elschnig considers it open to the same objection as the Panas operation, obtaining its effect by an unsightly shortening of the skin. His diagram of it, however, shows the skin flaps cut much higher than Machek described them, and in reality, the shortening of the skin is much less than might be supposed, not enough to interfere with excellent cosmetic results. In this country and England the operation seems hardly known; it is not mentioned in Beard's Ophthalmic Surgery, as the last edition of this appeared in 1916, or in the book of Grimsdale and Brewerton (1920), and questions among American colleagues reveal that few know of the procedure. The similar operation of Reese,[4] which was proposed in 1923, will be described later. Key [5] employed this procedure, which he called the Machek-Reese method, in a number of cases with good results, and he recommended it for various types of ptosis. Crigler [6] tried it in one case, but his result was complicated by an epithelial cyst.

The operation, according to Machek's description, was performed as follows: Six millimeters above the free lid border a horizontal incision was made, extending almost to the inner and outer canthi and including skin and orbicularis; 5 mm. above this a second incision, slightly longer, was made. This horizontal flap, 5 mm. wide, was cut in the middle, forming two flaps attached at either end of the lid. Vertical tunnels were then made from the ends of the flap to the upper part of the brow where short skin incisions were made. The skin flaps, after being denuded of epithelium by scraping, were pierced by double-armed sutures, drawn up into the tunnel and fixed there by tying the sutures

3. Machek: Arch. f. Augenh. **71**:8, 1914.
4. Reese, Robert: Tr. Am. Ophth. Soc. **21**:59, 1923.
5. Key: Arch. Ophth. **52**:375, 1923; in discussion of Reese (footnote 4).
6. Crigler, in discussion of Key (footnote 5, first reference).

at the level of the brow incision. The amount of effect obtained was graduated by the level of the upper incisions, these being made higher in more marked cases. A single dressing of petrolatum gauze and gutta percha paper covered by a bandage was employed and stitches were removed after from four to six days.

H. Gifford made a number of slight modifications which seemed to increase the effectiveness of the operation, and employed some technical maneuvers not mentioned in Machek's report, although perhaps employed by him, which greatly simplified its execution. It was found that when the flaps were made as in Machek's illustration, the

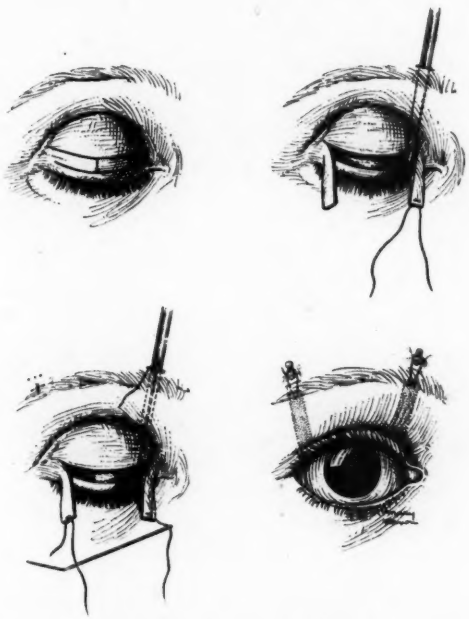

Fig. 1.—Technic of the Machek operation with slight modification.

effect was insufficient in extreme cases. This was remedied by making the lower skin incision not 6 mm., but 3 mm. from the lid border, which increased the amount of elevation possible, and by making the incisions and flaps shorter, as otherwise elevation of the lid was prevented by the resistance of the internal and external palpebral ligaments. The incisions were therefore stopped 3 mm. short of either angle, as shown in figure 1. The effect is tested by pulling upward on the flaps, and if resistance to full elevation of the lid is encountered, it may be necessary to shorten the incision slightly by sutures. It was found that slightly narrower flaps (from 3 to 4 mm. wide) were equally effective with less sacrifice of skin, which impaired the resulting fold. To obtain any considerable effect it was found necessary to make the incisions in the brow high.

where the tissues are fixed; hence these were always placed near the upper edge of the brow, and further pull was obtained by bringing the sutures out 4 mm. higher than this, so that the flaps could be pulled up to the level of the incision if necessary. The effect obtained was then graduated by the degree to which the stitches were tightened. In cases of complete ptosis the greatest effect possible is none too great, and the stitches are pulled up as far as possible, which may even pull the lid slightly away from the globe on the operating table.

Instead of removing the stitches in from four to six days, these are left in for two weeks unless they cut out sooner than this, an additional effect being sometimes obtained by inserting small rolls of gauze beneath the knots, which are originally tied over gauze rolls. The only cause of failure was the occasional premature cutting out of the sutures, and to prevent this, small needles were employed, armed

Fig. 2 (case 1).—*A*, the patient and his mother. *B*, appearance of the patient two months after an operation on the second eye.

with coarse silk or, better, no. 9 waxed linen. If the flap was cut in passing the needles, a new bite was taken further down or a slip-knot was placed around the end of the flap.

Details that simplify the operation include the use of fine non-cutting needles with straight shanks, slightly curved at the points. These are passed with blunt end first through the tunnel along a grooved director, as otherwise considerable difficulty may be experienced in getting them through. The tunnel is made from above with scissors instead of from below with the knife and is made wide enough to admit the flap easily. The epithelium is removed from the flap with trichloracetic acid followed by slight scraping with a scalpel. The complete removal of epithelium is necessary to prevent a fistula from the desquamation of epithelial cells (fig. 1).

A most important detail is the application of a dressing that will protect the cornea from exposure while avoiding any pressure on the lid, which would cause the stitches to cut out of the flaps. Various

dressings were tried, including the use of a cone of waxed paper filled with petrolatum. The best one proved to be a cone of x-ray film cleansed of its emulsion, and bound at the sharp edges by adhesive tape (I am indebted for this idea to Dr. C. S. O'Brien of Iowa City) (fig. 4 *B*). This is made of a size to fit the orbital margin, where it is fastened firmly enough to form a practically air-tight covering. This acts as a condensation chamber, and the test of its efficiency is the collection of moisture in droplets on its inner surface. The cornea may be observed through it, and it is worn for at least a week till a gentle

Fig. 3 (case 2).—Appearance of patient before operation.

Fig. 4 (case 2).—Appearance one month after second operation.

effort to close the lids as in sleep allows the cornea to be completely covered. All effort to close the lids is avoided for the first week, the shield being changed only when secretion is seen to be present, at which time the conjunctival sac may be cleansed with boracic acid solution. The only stitches necessary are those holding the flaps, since the pull on these closes the incisions in the lid and brow perfectly. The stitches are protected by a collodion dressing which is changed every two to three days, when the stitches are touched with two per cent silver nitrate. Occasionally a small stitch abscess occurs after a week or ten days, but this does not affect the result, and it is considered important to maintain the upward pull on the flaps until these have healed firmly

in place. When the dressing is properly applied so that the inside is constantly moist, the cornea remains perfectly smooth. When other dressings were tried a slight superficial keratitis was observed in several cases, but this healed when the dressing was improved without any visible scars and seldom required any treatment except the instillation of a mild antiseptic. In one or two cases in which the sutures cut out too soon, owing to improper dressing, the operation was later repeated with good results.

Photographs of four patients are shown, which illustrate the cosmetic result obtained. The resulting fold, which was the primary object of Machek's procedure, is well seen. The effect of elevating both ends

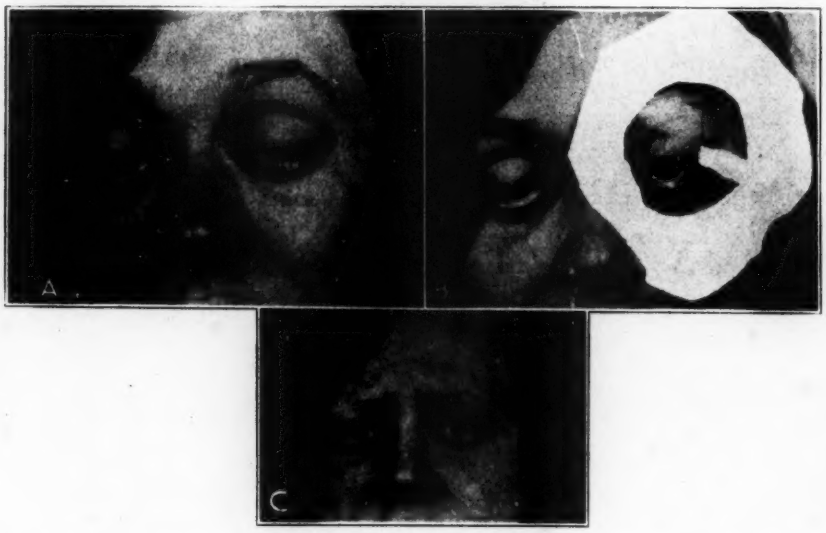

Fig. 5 (case 3).—*A*, appearance before operation; *B*, appearance three weeks after an operation on the left eye, showing the protective shield (a larger one than is usually employed); *C*, appearance three weeks after second operation.

of the lid is to give the resulting palpebral fissure a nearly normal shape, as contrasted with that produced by the Panas procedure, and sometimes by that of Motais, in which elevation of the central portion only gives the fissure a triangular shape. All were cases of almost complete bilateral congenital ptosis. The first case was complicated by unusual anomalies of the ocular movements, including complete absence of upward movement, and spasmodic nystagmoid lateral movements on attempts to turn the eyes down or down and laterally. The same condition was present in the patient's mother. Most operations were performed, one eye at a time, in the clinic under local anesthesia, and while in private practice the procedure is usually done in the hospital, the patients are allowed to leave the same or the following day.

Operation on both eyes is often performed at one sitting, and when only one eye is affected, an attempt is made slightly to overelevate the lid as compared with its fellow, when the final appearance is as nearly as possible alike on both sides. In the case of an infant with congenital ptosis and epicanthus, both eyes were operated on at once under general anesthesia, and a slight improvement in the epicanthus was secured by Verwey's procedure. This consists in horizontal Y incisions on the sides of the nose which are converted into Vs by advancing the apex of the Y to the base. The remaining fold, if not taken up with the development of the nose, may be improved later by repeating this procedure.

Fig. 6 (case 4).—*A*, congenital ptosis and epicanthus; *B*, appearance one month after a bilateral operation, showing the scars of the Verwey incisions.

One picture of the patient in case 3 is shown after only one eye was operated on, the degree of ptosis having been the same on both sides originally. (This eye and one eye of the patient in case 2 were operated on by Dr. Ralph Davis. One eye of the patient in case 4 was operated on by Dr. D. H. Loomis, and one eye of the patient in case 1 by Dr. Katherine Chapman.)

The procedure described by Reese varies considerably from Machek's, as the flap is not cut in the middle but at both ends, and these flaps, attached at their central portion, are passed up through tunnels as in the Machek procedure. Having met with the complication of sebaceous cysts in his first eight operations, Reese later left the skin in place, using only the underlying tongues of orbicularis muscle to form similar flaps. Derby,[7] in commenting on the procedure, brought

7. Derby, in discussion of Reese (footnote 4).

out the delicacy of these muscular flaps which may be pulled out of their attachment. The fenestrated knife described by Reese with which the tunnels were made and the threads pulled out as it was withdrawn would probably slightly shorten the procedure.

The objection made by some authors to the Machek procedure, that the buried skin flaps form cysts, can apparently be entirely obviated by using trichloracetic acid followed by scraping, as this complication did not occur once in these eighteen cases, while the use of the whole skin and orbicularis greatly strengthens the flaps and increases the certainty of obtaining the desired effect. Whether the flaps are left attached at the ends, as Machek advised, or near the center, as done by Reese, would not seem to be a vital matter. It is my belief that a greater effect on the whole lid can be obtained with the original flaps, provided these are not brought out too near the canthal ligaments, and that the resulting shape of the palpebral fissure and appearance of the skin fold more nearly resemble the normal when the flaps are employed in this way.

It is the idea of employing the two skin flaps which seems responsible for the almost uniformly good cosmetic results obtained. The appearance of the fold, the possibility of obtaining almost any amount of correction without regard to the condition of the superior rectus and the invisibility of the resulting scars recommended the operation to me as a most useful one in all types of ptosis. Good results will be obtained by careful observance of a number of small details, perhaps the most important being the proper appliance of a dressing such as has been described.

CHORIORETINITIS JUXTAPAPILLARIS (JENSEN)

FIRST HISTOLOGIC REPORT

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LOS ANGELES

In 1929 I [1] presented a review of this subject and stated that no histologic study of a definite case of chorioretinitis juxtapapillaris (Jensen) had been reported. Reference was made to Verhoeff's [2] histologic report of a case, the inclusion of which as a true case of chorioretinitis juxtapapillaris he himself questioned. His exact words follow: "The term chorioretinitis juxtapapillaris is certainly descriptive of the pathological condition found in the following case, although from an etiologic standpoint the latter probably does not belong to the class of cases described by Jensen."

It was my good fortune to obtain for study the complete set of sections of the left eye from a case which clinically supported the diagnosis of chorioretinitis juxtapapillaris.

REPORT OF CASE

H. H., the patient, a farmer, aged 26, presented himself for the first time to Dr. J. H. Roth at Kankakee, Ill., on Dec. 18, 1924, with the history of a "blind spot" before the left eye for four days, which was gradually increasing in size. There was no redness, photophobia or pain. The history was vague but suggestive of a similar attack two years before. This had cleared promptly without treatment, leaving a more or less constant "spot before the left eye" which the patient considered unimportant. The past history obtained at this time did not reveal anything considered important. The patient was sent to the office of his family physician where a physical examination revealed no abnormalities. The Wassermann reaction of the blood was reported negative at this time.

On December 18, the date when the patient was first seen, examination showed: R. V. = 15/15, manifest + 0.75 + 0.50 cyl. 90 = 15/15; L. V. = 15/200, manifest + 2.00 = 15/25. External examination of each eye gave entirely negative results. Tension in the left eye was 20 (Schiötz-Gradle). On examination through the undilated pupil there appeared to be a choroiditis in the temporal margin of the left disk, though it was not extensive. Atropine was prescribed for refraction and study.

Work done while instructor in the Department of Ophthalmology, University of Chicago, Dr. E. V. L. Brown, Director.

Dr. J. H. Roth furnished the author his notes on the early findings and left fields in this case, and sent the enucleated bulb to Dr. E. V. L. Brown.

1. Abraham, S. V.: Retinochoroiditis Juxtapapillaris—Jensen, Arch. Ophth. **2**:452 (Oct.) 1929.

2. Verhoeff, F. H.: A Case of Syphilitic Retinochoroiditis Juxtapapillaris with Microscopic Examination, Tr. Am. Ophth. Soc. **14**:568, 1916.

On December 23, under atropine, examination revealed: R. V. with + 2.50 + 0.50 cyl. 90 = 15/15; L. V. with + 4.00 + 0.50 cyl. 90 = 15/60.

Examination of the fundus at this time gave negative results for the right eye, but in the left there was found a slate-colored tumor mass lying practically on the rim of the left disk, extending from 1 to 5 o'clock and reaching a third of the way to the macula. This tumor mass was irregular, the broadest diameter being at 3 o'clock. A small bridge of tissue reached across the mass to a minute lighter area near 1 o'clock. The main mass extended about 0.5 disk-diameter above the disk and temporally as far as 1 disk-diameter. The elevation measured about 4 diopters. Extending from this mass were fine striae, radiating over the temporal region of the fundus. A serous detachment of the retina seemed responsible for these striae. The fields taken on this date are shown in figure 1, *1*.

On December 27, with correction, vision in the left eye was 15/200; on Jan. 10, 1925, with correction, 1/200.

On January 12, the patient was seen by two eminent opthalmologists who considered this to be a case of sarcoma of the choroid. The patient was kept under observation, and during the next few weeks the eye was examined by most of the leading ophthalmologists in Chicago and vicinity. On January 19, the patient was seen informally by a group of members of the Chicago Ophthalmological Society, all but one of whom diagnosed the condition as sarcoma of the choroid (fig. 7). Vision in the left eye on this date was limited to perception of hand movements in the temporal field. Finally, sixty-two days after the first visit, on February 18, the left eyeball was enucleated, placed in a diluted solution of formaldehyde U. S. P. (1 : 10) and given to Dr. E. V. L. Brown.

The patient was again seen on Sept. 25, 1929, with a history of blurred vision in the right eye for two weeks but still with no redness, pain or photophobia. The patient was admitted to Billings Hospital with a diagnosis of chorioretinitis. Here the following history was obtained after laborious, detailed questioning.

The last attack, which brought the patient to the doctor on September 25, had started ten or twelve days before, with a mild continuous blur. The patient kept at work on the farm. Four days before he presented himself, vision became definitely worse. At no time was there any redness or pain.

The past history was interesting. The patient had had attacks of blurred vision since 1918, which lasted from one-half to one day and which occurred at least once a year thereafter, sometimes in the right eye, sometimes in the left and occasionally in both eyes. At times he could not see enough to unharness the horses. He had his worst attack in the left eye in 1924. This had started just like the others, but the condition became worse. Finally, as already noted, the left eye was enucleated.

Between February, 1925, and September, 1929, attacks continued as before in the right eye, one or more times each year with one more severe attack in 1926. In August, 1929, an attack started, but lasted only a half day. In September the present attack began.

The general history was essentially unimportant except for (1) headache for many years and (2) frequent colds, rather lengthy during the winter months. The latter had been present for ten or eleven years. The patient coughed up greenish, walnut-sized mucous plugs at rather frequent intervals. Sore throat accompanied the colds. The history by systems failed to reveal anything else.

Physical examination revealed a well nourished white man about 30 years of age, weighing about 175 pounds (79 Kg.). The essential findings were as follows: Examination of the eyes showed a prosthesis on the left side; the right eye will be described later. The mucous membrane of the nose was red and sensitive; no pus was present and none was obtained on suction. The mouth was in poor con-

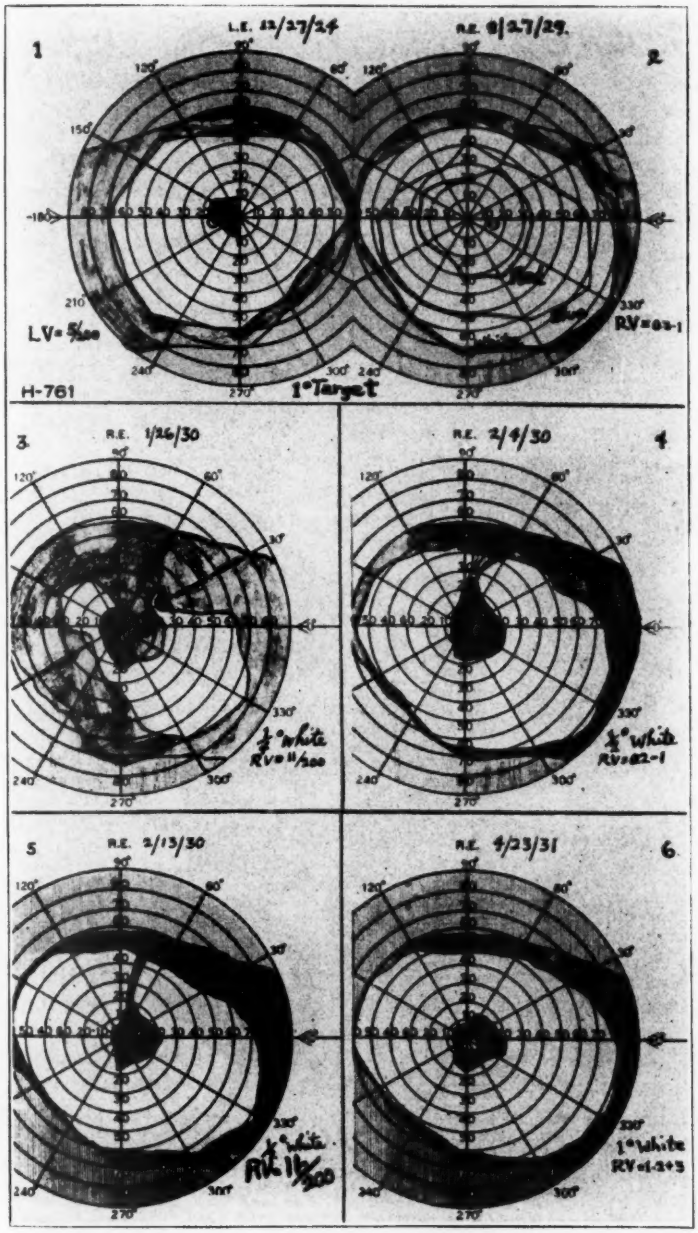

Fig. 1.—Peripheral fields (taken with the modified Ferree-Rand perimeter): *1*, only field of the left (enucleated) eye showing a defect continuous with the blind spot reaching the fixation point; the peripheral field is slightly contracted; *2*, right fields for red, white and blue; *3*, sector-formed defect with a one-fourth degree target after regression has started; there is a decreased peripheral field; *4*, regression; a relative scotoma extends to the periphery (lightly shaded); *5*, further regression; the defect for 1 degree red and blue is still about the same as in *3*; *6*, absolute scotoma not materially altered (fourteen months) except for the islet of central vision; the peripheral field is practically normal.

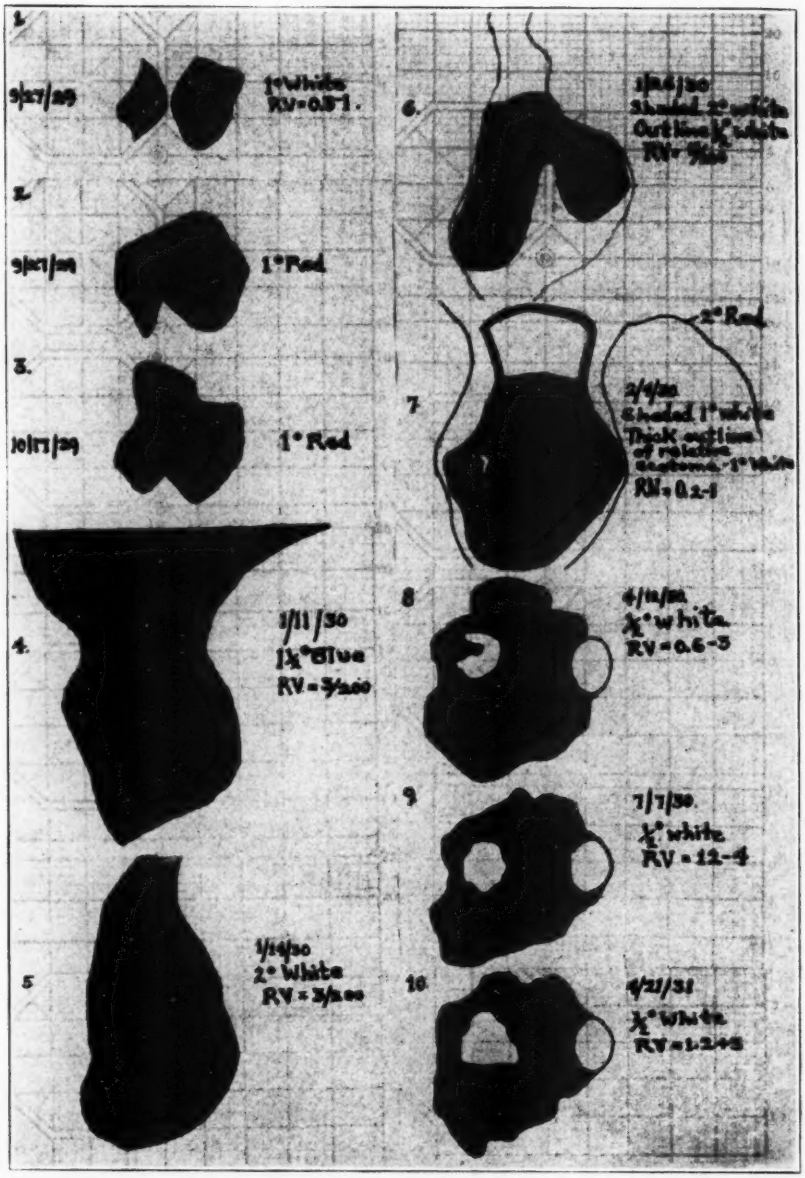

Fig. 2.—Central fields taken with Lloyd's stereocampimeter, showing the growth and regression of the scotoma: *1*, blind spot not continuous with the scotoma as shown with a 1 degree white target; probably the defect would be larger and continuous with the blind spot if a smaller target had been used; *2*, blind spot continuous with defect, on the same day, with 1 degree red; *3*, tonguelike projection upward; *4*, complete sector-formed defect shown also in the peripheral field the same day; *5*, beginning regression—still sector-formed; *6*, still sector-formed with a one-half degree target, shown in the peripheral field with one-fourth degree (not one-half degree) white; *7*, further regression, though the sector form is still present with a 2 degree red target; note the islet of vision near the fixation point; *8*, definite increase in the size of the islet with a corresponding increase in vision; note the outline of the blind spot showing continuity with the defect only on its nasal half (in the field); *9*, *10*, only slight differences; i. e., the defect was fairly constant over a period of one year except for improvement within 1 degree of the fixation point. The field taken with the Bjerrum screen, April 23, 1931 (2:1,000), showed practically the same condition as in *10*, though the defect came closer to the fixation point.

dition. Large congested tonsils were seen. Special examinations by staff members of the ear, nose and throat, dental, chest, gastro-intestinal, genito-urinary, neurologic and dermatologic departments before and after extensive laboratory tests supported only the findings noted. The usual tests of the urine, blood and spinal fluid gave negative results as did culture of the blood. Roentgenograms of the sinuses showed a clouding of the lateral portion of the right antrum.

Roentgenograms of the chest on Sept. 28, 1929, revealed normal lungs. Reexamination on Feb. 4, 1930, showed slightly increased hilar calcification. Cutaneous tests with Long's tuberculin in dilutions of 1 : 10,000, 1 : 1,000 and 1 : 100 on Sept. 30 and Oct. 2, 1929, and on Jan. 14, 1930, were negative. The Mantoux test on February 4 was definitely positive.

Examination of Right Eye.—When the patient was seen on Sept. 25, 1929, the best right vision was 15/60. External examination of the right eye gave negative results, and the anterior segment was normal throughout. Examination by indirect ophthalmoscopy through a 7 mm. pupil showed clear media. The right disk showed no pigment ring. The nerve fiber arrangement was accentuated, but there was no definite swelling or edema. From 1 to 1.5 disk diameters temporal to the upper

Fig. 3.—Photograph (by Dr. L. Bothman) of the right fundus on July 8, 1930, for comparison with figure 8.

one fourth of the disk was an area, measuring 0.5 by 0.75 disk-diameter, in which could be seen five or six slightly irregular, sharply outlined, quadrilateral, thin, definitely brownish plaques at the levels of the nerve fiber layer and the midretina. They seemed very thin and definitely related to the arterioles in nearly every instance. There were no white areas or hemorrhages of the ordinary type and little or no definite forebulging of the retina except as indicated by a bending vessel near the flecks. No other central retinal or choroidal lesions were present. The binocular ophthalmoscope showed a round disk-shaped, conically elevated grayish forebulging of the choroid (?) and retina 1 disk-diameter temporal to the center of the right disk. The macular artery made a definite bend forward as it coursed over it through an area of 0.75 disk-diameter in size. The hemorrhages lay above the prominence and came from the arterial, not the venous vessels. The adjacent retina and choroid showed no definite added pathologic changes. Treatment was instituted and carried out promtly. Cultures were made from the nose and throat, and a vaccine of the various organisms was prepared for purposes of injection. The organisms found were: Staphylococcus albus, Micrococcus catarrhalis, Streptococcus viridans and some indifferent streptococci. Fusiform bacilli were also found in a culture from the mouth for suspected Vincent's angina, but these were not used in the vaccine. Injections of vaccine were started on Feb. 14, 1930, and continued weekly until April 12. Mild local reactions, and at one time moderate

general reactions (chills), were obtained. Subcutaneous injections of increasing strength of Long's tuberculin were started on February 5, and continued for several months.

On Oct. 3, 1929, following the removal of the tonsils, vision in the right eye was 20/30 — 2. The fundus seemed clearer and the main prominence temporal to the disk smaller and lower (fig. 8 *A*). On October 4, pus was found in the right antrum, and the next day this sinus was explored, a polypoid condition found and a "window" made. Vision continued to improve, and on October 12, the patient was discharged with unaided vision of 20/25 + 1 in the right eye, but the disk and the elevated area temporal to the disk were unchanged. An abnormal area, measuring

Fig. 4.—Photomicrograph (section 152), showing the lesion practically limited to the temporal side: *A*, lymphocytic nodule; *B*, organized mass; reduced from × 50.

0.5 disk-diameter, below and temporal to the large area was also noted. It was chocolate tinged and granular. The upper irregular margin was glistening white. The blood vessel passing over it was more tortuous, and the retina between the two lesions had a moth-eaten appearance. A minute fresh hemorrhage was also seen. No visual disturbance occurred until about Christmas, 1929, and on Jan. 3, 1930, unaided vision in the right eye was 4/200 and no glass improved it. Examination of the fundus on this date showed a white elevated area extending temporally from the margin of the disk at 3 o'clock. A vessel bent forward as it passed over this lesion. Extending from the temporal side of the disk for a

distance of 3 disk-diameters horizontally and 5 disk-diameters vertically was a kidney-shaped, sharply outlined, chocolate-tinged area containing numerous well defined smaller areas (fig. 8 *B*).

On January 17, the following detailed description of the fundus was made and is quoted from the records:

"There is a large, irregular, very slightly elevated, kidney-shaped area extending upward from the disk margin from 12 o'clock for 0.75 to 1 disk-diameter and temporarily from 2 o'clock for about 2.5 disk-diameters, reaching beyond the fovea itself. The margins of this area are fairly well defined from the rest of the fundus, especially the major part of it which extends downward from the disk at 6 o'clock,

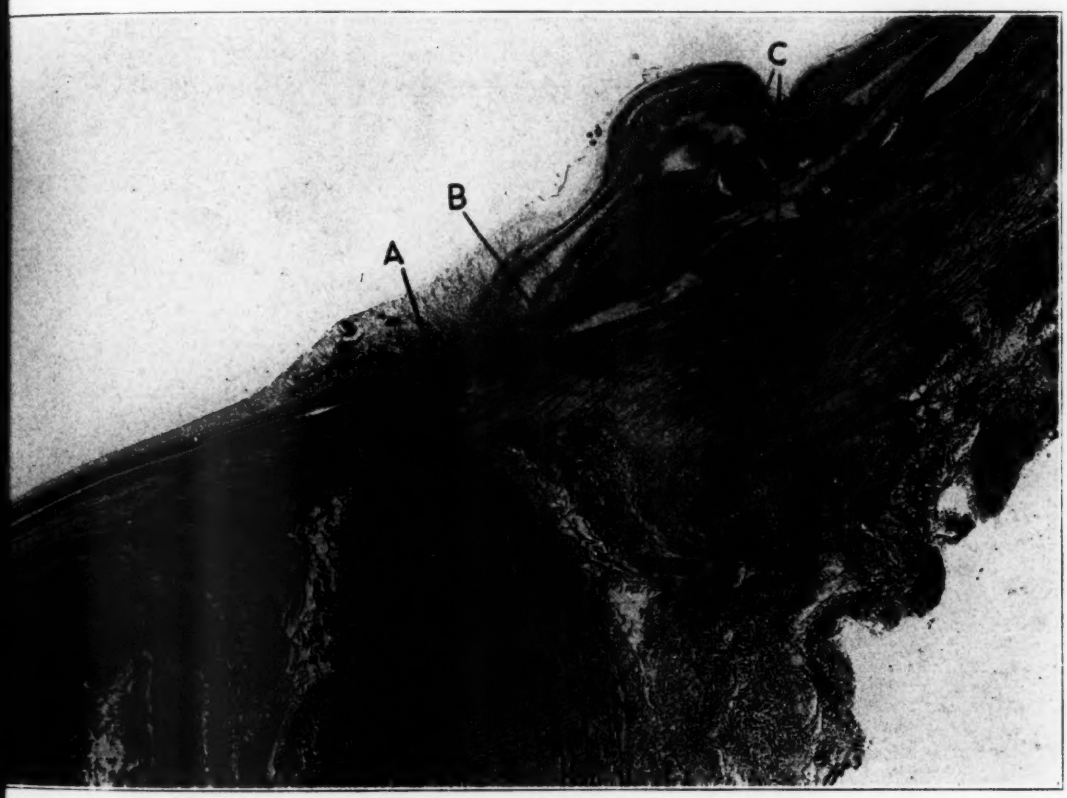

Fig. 5.—Photomicrograph (section 110), showing a marked difference between the temporal and nasal retina and choroid: *A*, lymphocytic infiltration; *B*, organized mass; *C*, hemorrhagic areas; reduced from × 20.

curves temporally (with the convexity below) and continues upward to just below the level of the fovea, toward which the temporal border of the lesion curves. The upper margin of the lesion blends with the normal retina gradually, so no definite border is seen here. This area contains most of the pathologic changes of the eye. Within this outlined area and adjoining the temporal margin of the disk at 9 o'clock is a dense grayish-white, slightly more prominent lesion about 0.6 disk-diameter in size with borders merging into the surrounding region. The disk margin is blurred in the temporal half, and especially so is the region extending from 8 to 10:30 o'clock. The nerve fiber arrangement is accentuated. The

immediately surrounding area in the upper temporal quadrant shows numerous reflecting points from the retinal surface, and many striated as well as minute round whitish spots can be seen at the same level as and deeper than the retinal blood vessels. In its nasal half the disk margin can be seen fairly well. The smaller blood vessels near the disk are definitely dilated and the larger arteries are slightly more tortuous than normal, especially the superior temporal artery about 1.5 disk-diameters from the disk margin. In the region just below this artery, before it divides, one can see several minute and two small round old hemorrhages, no larger than the diameter of the artery. The veins are slightly dilated, especially the inferior temporal vein. The lower branch of the superior temporal vein arches

Fig. 6.—Same as figure 5, between *A* and *B*. Note that the lymphocytic infiltration (*A*) is primary in the choroid. Note, too, the organized mass extending into the retina and retroretinal area from the choroid, which is fused to the retina by this mass (*B*); × 175.

slightly above the aforementioned grayish-white lesion. Numerous capillaries extend forward and over this same lesion. Temporal to this lesion one is first struck by the numerous radiating folds (from one-half to two-thirds the arterial diameter in thickness and 2 disk-diameters from the disk margin). These begin 1 disk-diameter from the temporal border of the disk and extend for an area about 1.5 disk-diameters in size, reaching almost to the temporal margin of the affected area first mentioned. These folds and the yellowish translucent condition of most of the retina throughout this kidney-shaped area suggest serous detachment of the

retina, with the previously mentioned lesion bordering the disk showing fibrinous exudate. The rest of this kidney-shaped area appears moth-eaten, being studded with innumerable yellowish-white, round or oval, sharply outlined areas. There is no definite pigment clearly seen, though the background, a little of which is seen between the yellowish fatlike deposits, seems brownish or chocolate tinged. The

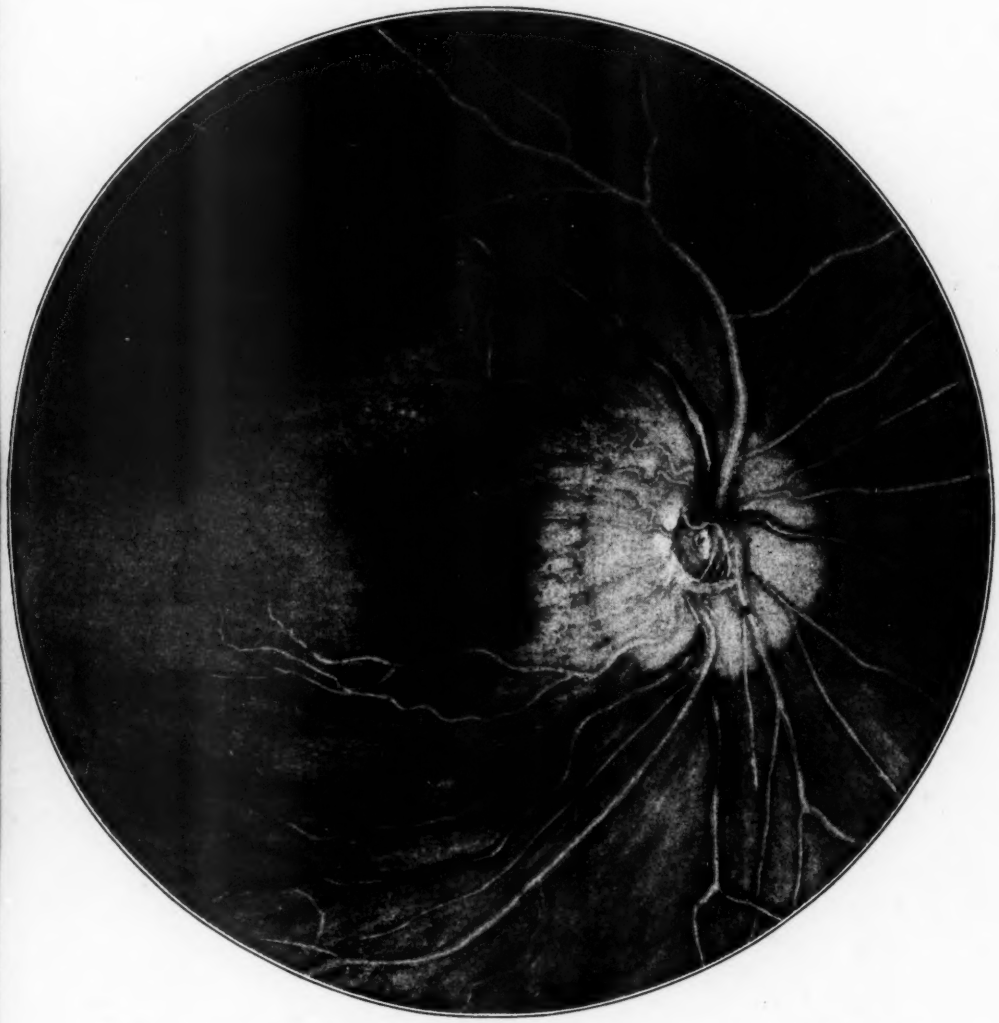

Fig. 7.—Direct view of the fundus of the left eye on Jan. 19, 1925 (later this eye was enucleated).

fatlike, sharply outlined areas vary in size from 0.05 to 0.2 disk-diameter, and are located just behind the blood vessels. In addition to the single large area, which (it is suggested by earlier examination and history) is composed of several confluent areas, there is an isolated lesion of fuzzy outline, yellowish-white, slightly derounded and located from about 0.5 to 0.75 disk-diameter from the lowest margin of the large area and about 5.5 disk-diameters from the disk. A minute yellowish

spot with no pigment is also noted about 1.5 disk-diameters nasal to this one and equally distant from the disk."

The sinuses and throat were clear at this time, and concentrated attention was given to the oral hygiene; infected teeth were removed. On January 25, vision in the right eye was 11/200, the fundus lesion clearing above and progressing below. The fundus picture continued to improve, and on February 15 the patient was discharged from the hospital with vision of 0.2 — 1 in the right eye.

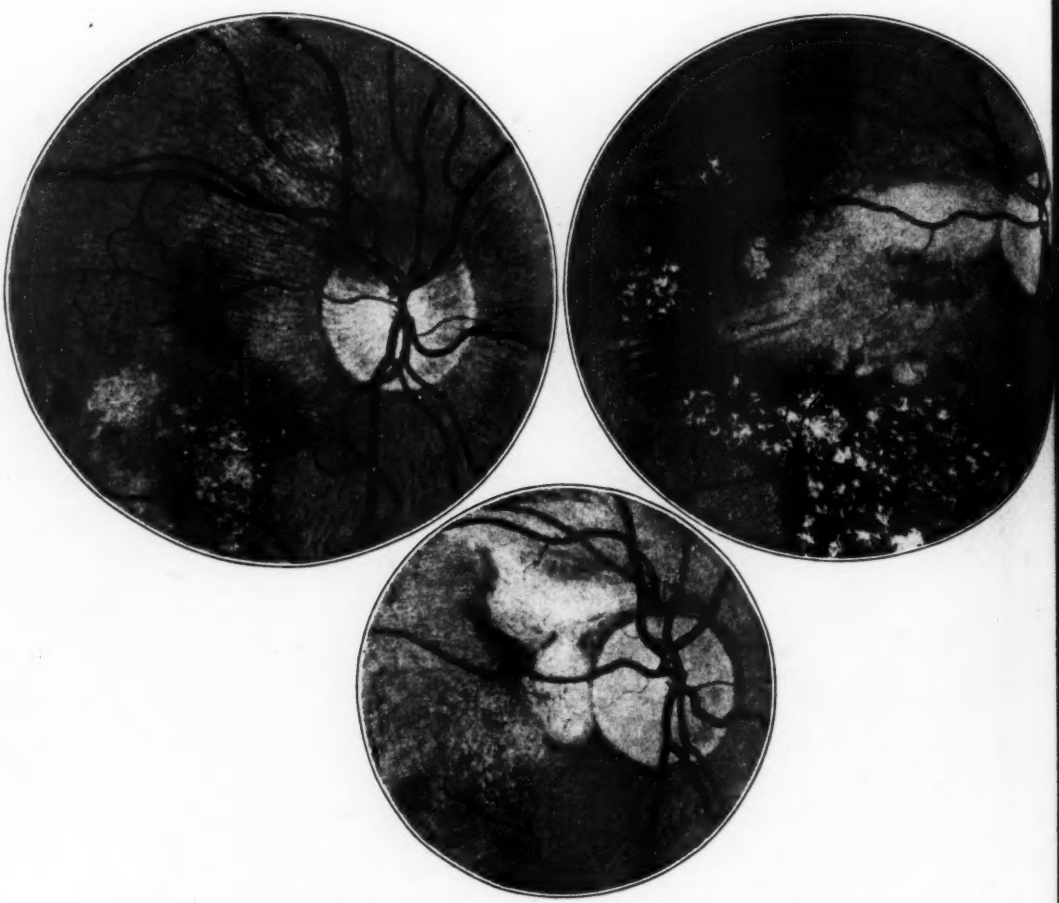

Fig. 8.—*A*, direct view of the fundus of the right eye on Oct. 3, 1929. *B*, the fundus on Jan. 4, 1930. *C*, the fundus on April 30, 1931.

A note on March 8, stated: "The slate colored tumor-like mass bordering the disk is definitely decreased in size and shows a yellowish irregular border deeper than the surface of the lesion. The surface is 3 diopters higher than the surrounding blood vessels. The kidney-shaped lesion is less mottled and smaller." On March 3, vision in the right eye was 0.4. On March 12, the record said: "Most marked local reaction to tuberculin given 3/2/30 (0.5 cc. of a 1:10,000 dilution, subcutaneously). R. V. = 0.6 — 3. The fundus shows the most marked improvement thus far seen." On April 5, vision in the right eye was 0.8 + 2; on July 7, 1.2 — 4 (fig. 3). On August 26, vision in the right eye, with and without correction, was

1.2 — 4. On December 6, a letter from the patient stated: "My eye is still about the same, but I think there is a slight improvement in it." He came in, on request, on April 23, 1931, with the right eye under atropine. Examination showed: R. V. with + 2.50 + 0.50 cyl. 105 = 1.2 + 2. The patient stated that for the first time in many

Fig. 9.—Drawing of *A* and *B*, figure 4; × 110 (approximately).

years he had gone through a winter without colds. His vision had suffered no set-backs. He still noticed an occasional flickering, but definitely stated that the "hole" through which he saw was getting larger. The fundus on this date showed that the original lesion was still present between 8 and 12 o'clock, bordering the disk. It was greenish white, triangular and elevated about 2 diopters; its greatest diameter was slightly less than 1 disk-diameter. It contained two streaks of pig-

ment. The entire macular region was darker than normal and showed an even darker (questionably pigmented) foveolar region of 0.5 disk-diameter. Two minute glistening spots could be seen below the macula. Surface reflexes seemed increased. About 6 disk-diameters below the disk was an area, 0.5 disk-diameter in size, of choroidal atrophy without pigment (fig. 8 *C*).

The fields taken throughout the progress of the disease, with the dates they were taken, are shown in figures 1 and 2. The drawings, too, with dates, are shown in figures 7 and 8. These are supplemented by photographs of the fundus, one of which is shown in figure 3.

Comment.—That the fields show sector-formed defects, extending from the blind spot to the "periphery," is readily seen if one recalls that the nerve fibers to the macula *end* therein; that is, this area is the "periphery" for these fibers. Jensen's [3] case showed a field defect passing very close to the fixation point. The visual acuity was permanently impaired. Groes-Petersen's [4] case 2 showed a field defect encircling the fixation point reaching to the raphé. His case 9 showed a field defect approaching the fixation point. His case 10 showed a field defect involving a part of the sector ending in the raphé just nasal to the fixation point. The vision in this case was permanently impaired. His case 13 showed a field defect almost touching the fixation point extending from the blind spot.

The lesion is ophthalmoscopically typical for the group of cases described by Jensen, namely, an inflammatory mass bordering the margin of the disk, involving only a part of the margin and clearing later with signs remaining at this marginal area. In several of Groes-Petersen's cases the lesion was located similarly to the one here reported. Appleman [5] seems to have been the only one who recorded the elevation of the lesion. Others noted the prominence, but Appleman said that the elevation measured 3 diopters. The lesion in his case was temporal to the disk and extended to the neighborhood of the macula. About 25 per cent of the cases reported showed some permanent impairment of vision. About 80 per cent showed some temporary visual disturbance. The history and observations of recurrences in the same area in our case are also in keeping with other cases of this group. Verhoeff's case followed closely on a primary tonsillar lesion; it was so extensive as to involve the entire area around the disk, and there was a widespread detachment of the retina. Within two weeks a severe iridocyclitis was evident. The fields could not be ascertained. Except, then, for the finding of an extensive granulating lesion completely surrounding the disk, there is no resemblance between Verhoeff's case and any other

3. Jensen, E.: Retinochoroiditis Juxtapapillaris, Arch. f. Ophth. **69**:41, 1908.

4. Groes-Petersen: Retinochoroiditis (Jensen), Klin. Monatsbl. f. Augenh. **50**:159, 1912.

5. Appleman: Retinochoroiditis Juxtapapillaris, Ann. Ophth. **23**:425, 1914.

reported case of chorioretinitis juxtapapillaris. His finding of a proliferative endovasculitis of the retina, especially of the arteries, with incomplete obstruction and thrombosis of a branch of the central artery, suggests that the condition found was, beyond doubt, unrelated to Jensen's group of cases, and, even if less severe, the picture found in Verhoeff's case would be entirely unlike that in any of the reported cases of chorioretinitis juxtapapillaris.

The report of this case is therefore, as previously stated, the first histologic report of a true case of chorioretinitis juxtapapillaris (Jensen).

Pathologic Anatomy.—The external description of the enucleated left bulb by Dr. L. Bothman after nine days in a diluted solution of formaldehyde was: "The left bulb measures 23.5 (anteroposterior) by 21 (horizontal) by 23 mm. (vertical), and the cornea is 11.5 by 11 mm. (horizontally oval). The opticus is 7.5 mm. long, straight and cut obliquely; the temporal portion is longest. Tags of the oblique are 5 mm. long; the superior and internal recti are 3 mm. long; the other muscles are flush with the sclera. The cornea, sclera, anterior chamber and iris are normal. The sphincter region appears as a brownish ring on the pupillary border. The pupillary space is filled with an opaque gray substance (lens)."

A superior calotte was removed by Dr. E. V. L. Brown, who noted: "After removal of a superior calotte the partly coagulated vitreous is found firm and nonliquid, and the retina and choroid in situ except for a 5 mm. area some 3 mm. temporal to and above the disk, where there is a slightly brownish, rounded, forebulging of the retina, 2 mm. high. Its horizontal diameter is slightly greater than its vertical, its sides steep and rounded; a narrow dark horizontal depression runs through the center of the mass in its nasal two-thirds."

Histologic Report.—The cornea, anterior chamber, iris, iris angle and sclera were normal except for a slight increase in the thickness of the vessel layer of the pars planum ciliaris, especially on the temporal side; the ciliary body, too, appeared normal. No demonstrable vitreous changes were seen. The internal limiting membrane was everywhere intact except where mechanically disturbed in sectioning.

The retina, temporal to the disk, was grossly detached from the choroid through an area measuring approximately 5 mm. horizontally and 8 mm. vertically. The main elevated mass was just temporal to the disk itself and measured about 1.5 mm. horizontally and 3.5 mm. vertically. The detachment was caused by a hemorrhagic coagulum which separated the choroid, which was from three to five times the normal thickness, from the edematous retina, from three to eight times the normal thickness. The chief changes in the retina seemed to be secondary to the detachment and the hemorrhage into it. Congestion and necrosis were evident chiefly in the nerve fiber layer and the ganglion cell layer. Hemorrhage and organization with the formation of granulation tissue involved chiefly the layer of rods and cones, the outer nuclear layer and the outer plexiform layer. A slight flat detachment of the retina extended perhaps from 1 to 1.5 mm. beyond the grossly detached region. The nerve fiber layer showed vacuoles over an area even further removed from the main lesion.

At its maximum (almost 0.8 mm. above the horizontal diameter of the disk) the elevation measured about 0.6 or 0.7 mm. in height. The nerve fiber layer was markedly vacuolated and from two to three times its normal thickness. The ganglion cell layer as well as the inner nuclear layer showed moderate degenera-

tive changes, being disorganized and staining poorly, especially around the dilated retinal vessels. There was an increase in nuclei in the nerve fiber layer, chiefly polymorphonuclear leukocytes. The inner plexiform layer was granular and was invaded by vacuoles extending from the nerve fiber layer. The outer plexiform layer was more nearly normal, showing chiefly an increase in thickness and less fibrillation than normal. The outer nuclear layer showed the least changes of a degenerative character except where it was mixed with the organized mass to be described. The layer of rods and cones retained the fibrillar character surprisingly well, though somewhat faintly as they extended into the pink-staining albuminous exudate which lay between the retina and the swollen pigment epithelium. A hemorrhagic area extended through the coagulum, from the choroid toward the retina. Small ovoid and irregular-shaped areas were noted in the outer half of the external plexiform layer. Some of these contained pink-staining albuminous material. Similar areas were also seen in the subretinal fluid. The external limiting membrane was well seen, except in the region of the organized mass.

Three cystic spaces were noted just nasal to the macula. One was lined by ganglion cells; another was found in the outer plexiform layer, lined by rods, cones and cells of the outer nuclear layer; the third was in the inner plexiform layer and lined by cells of the inner nuclear layer. These were seen to contain degenerating blood cells in some sections, and predominantly fibrin and débris in others; the spaces seemed to owe their existence to folding of the various layers after hemorrhage into them and thickening of the nerve fiber layer. The tissue on each side of the most nasal cyst first showed organization in a section about 1 mm. above the disk. The definite organized chorioretinitic mass of granulation tissue was almost 0.75 mm. in extent, jutting out from the margin of the disk and fusing about 0.25 mm. of choroid, from which it originated, to the retina. One section showed an isolated synechia between the choroid and retina due to a strand of connective tissue. The hemorrhage into the retroretinal area and into the layer of rods and cones, as well as into the outer plexiform layer, could be traced to the vessels of the new-formed tissue. This organized mass was elevated about 0.2 mm. as its maximum, lay partly in the choroid and therefore contained pigment from this layer, especially evident near its origin. This granulation tissue hugged the margin of the disk and measured about 2.5 mm. vertically and from 0.4 to 0.5 mm. horizontally.

The most interesting observation was the intensive lymphocytic infiltration around the plexus of short ciliary vessels (circle of Zinn), the infiltration almost completely surrounding the optic nerve. The infiltration was practically limited to the choroid and was absent only in a 1 mm. central nasal area. This infiltrated area was most marked in the region chiefly involved in the pathologic process and was closely connected to the organized mass; this made its location appear of etiologic significance. The vessels in the dural sheath and in the optic nerve were definitely dilated, those on the temporal side being much more involved than those on the nasal side. In several sections the choroidal pigment on the scleral side seemed melted away by the pressure of the markedly distended choroidal vessels. The choroid was extensively necrotic in these areas. The lamina vitrea was intact except near the site of the organized mass. Except for apparent papilledema in sections passing through the periphery of the disk margin, the optic nerve head showed only a minimal edema, visible on the temporal one-third. These changes were interpreted as secondary to the transudation following congestion. The optic nerve itself was practically normal.

Summary.—In this case of chorioretinitis juxtapapillaris, one eye was enucleated because of possible sarcoma and the remaining eye showed a similar condition which

cleared and remained clear for twelve months following (1) the removal of infected tonsils, (2) the clearing up (by operation) of an infected antrum and (3) the removal of teeth and the treatment of the gums. Despite an unusually thorough study, nothing else was found, unless significance should be placed on the improvement in the eye coincidental with the finding of a plus tuberculin reaction previously negative. This, together with a slight increase in calcification of the glands in the hilus over the period of observation, was interpreted as possibly indicating a tuberculous basis for the condition. There was admittedly little to support this contention. Histologically, the enucleated eyeball showed a steep fold of detached retina in the region of the fovea centralis, extending to the temporal margin of the disk. The nerve fibers of the nerve fiber layer and inner and outer plexiform layers were rarefied and degenerated. Vacuoles were present, probably from the necrosis of some fibers. The nuclei of the various layers also showed degenerative changes. In the region immediately adjoining the disk there was found a large mass of granulation tissue extending from the choroid into the outer layers of the retina. Hemorrhages originated from the newly formed and distended vessels of this mass and from the choroid and retina. The albuminous retroretinal fluid contained large groups of red blood cells. The choroid was thickened and its vessels were widely distended. The pigment cells were swollen and in part necrotic. There was an extensive lymphocytic infiltration around the vessels of the circle of Zinn (figs. 4, 5, 6 and 9).

COMMENT

Except for the marked involvement of the choroid and the lymphocytic infiltration the histologic picture certainly suggests Coats' [6] exudative retinitis, and the late Prof. E. Fuchs, after a hurried glance at one of the sections, suggested that possibility. However, it seems definite that the initial changes were in the choroid, and that the retinal changes could easily be explained as dependent on the congestion and edema following detachment, with further changes following organization and hemorrhage. It seems logical to assume that the initial process was an inflammatory one due to infection or intoxication involving chiefly the temporal half of the circle of Zinn.

It is rather interesting to mention that the only ophthalmologist to disagree with the diagnosis of sarcoma in this case was one of three who later considered a true case [7] of sarcoma of the choroid in a man past 60 to be one of chorioretinitis juxtapapillaris. The clinical diagnosis had been supported by a definite sector-formed defect continuous with the blind spot. Microscopic sections, however, showed sarcomatous tissue. This emphasizes the importance of considering this type of chorioretinitis in a differential diagnosis of intra-ocular tumors, though R. I. Lloyd [8] failed to mention it (he mentioned, however, retinitis exudativa).

6. Coats, G.: Forms of Retinal Disease with Massive Exudation, Roy. London Ophth. Hosp. Rep. **17**:440, 1908.

7. This second patient was one studied by Dr. Emil Deutsch, who gave permission to use these data.

8. Lloyd, R. I.: Fundus Conditions Requiring Differentiation from Intra-ocular Tumor, Am. J. Ophth. **11**:599, 1928.

In an article on peripapillary detachment of the retina in papilledema, A. B. Reese [9] emphasized the probable relation of this detachment to the cause of the increased size of the blind spot, for as long as the layer of rods and cones is separated from the pigment epithelium the area involved will not function. However, a defect involving the entire area through which a nerve fiber passes and continuous with the blind spot, if caused by an intra-ocular lesion, must be caused by a loss of continuity of function at or near the disk margin and in the nerve fiber layer. There seems no need to consider the cause to be other than a loss of continuity due either (1) to the destructive effect of the edema of this area of the nerve fiber layer or (2) to excessive traction on the nerve fibers following the sharp detachment in this region.

CONCLUSION

A case of bilateral chorioretinitis juxtapapillaris (Jansen) is reported in detail with histologic observations in one eye. The data indicate that the condition is a chronic inflammatory process primary in the choroid and involving the plexus of vessels forming the circle of Zinn. The changes in the retina are secondary. While in this case no changes were noted in the anterior segment on histologic examination of the enucleated eye or on slit-lamp examination of the remaining eye, there is no reason for presuming that involvement of this portion cannot occur.

I believe that the name chorioretinitis juxtapapillaris should be retained for those cases in which the inflammatory lesion of the fundus borders the disk and in which a sector-formed defect continuous with the disk is present.

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9. Reese, A. B.: Peripapillary Detachment of the Retina, Tr. Am. Ophth. Soc. **28**:341, 1930.

GERMICIDAL EFFECT OF ULTRAVIOLET RAYS ON THE VIRUS OF HERPES

EXPERIMENTAL STUDIES

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Much confusion exists as to the value of ultraviolet rays in the treatment of infectious and other disorders of the eye. Brilliant results have been described in the neuropathic group of diseases, and particularly in the herpetic group, in which dendritic keratitis is outstanding. These observations have been made only in isolated cases or in small groups of cases such as reported or cited in discussions by Duke-Elder,[1] Bernd,[2] Post,[3] Walker,[4] Gifford,[5] Green,[4] Stock,[6] Peppmüller[7] and others. As far as I know, no definite experimental investigations have been made on the germicidal effect of ultraviolet rays on the virus of herpes.

On ordinary bacteria, the effect of ultraviolet irradiation is well known. It has been clearly shown by Verhoeff[8] that ultraviolet rays cannot under any conditions destroy bacteria within the cornea, even when the latter is perfectly transparent, without at the same time severely injuring the corneal tissue. Destruction of bacteria within the transparent cornea was obtained only when an intensity and exposure were employed sufficient to cause complete destruction of the corneal corpuscles and intense injury to the corneal lamellae.

The pathologic effects of ultraviolet irradiation on the eye have been determined by Verhoeff and Bell.[9]

From the Howe Laboratory of Ophthalmology, Harvard University.

1. Duke-Elder, W. S.: Ultra-Violet Light in the Treatment of Ophthalmological Diseases: 2. Local Phototherapy, Brit. J. Ophth. **12**:353 (July) 1928.

2. Bernd, W.: Klinische Beitrag zur Behandlung des Herpes Corneae, Klin. Monatsbl. f. Augenh. **83**:818, 1929.

3. Post, L. T.: Ultra-Violet Light Ocular Therapy, Tr. Am. Ophth. Soc. **29**:220, 1931.

4. In discussion of Post.[3]

5. Gifford, S. R.: Light Therapy in Ophthalmology, Tr. Am. Acad. Ophth. **33**:195, 1928; in discussion of Post.[3]

6. Stock: Klin. Monatsbl. f. Augenh. **76**:532, 1926.

7. Peppmüller: Klin. Monatsbl. f. Augenh. **74**:219, 1925.

8. Verhoeff, F. H.: Ultra-Violet Light as a Germicidal Agent, J. A. M. A. **62**:762 (March 7) 1914.

9. Verhoeff, F. H., and Bell, Louis: The Pathological Effects of Radiant Energy on the Eye, Proc. Am. Acad. Arts & Sc., July, 1916, vol. 51, no. 13.

From a general standpoint it is known that exposure of the skin to ultraviolet rays increases the bactericidal powers of the blood. The best effect of this kind is produced by a mild erythema of one quarter of the body surface (Eidinow). Excessive doses diminish this hemobactericidal power and introduce a so-called "negative phase."

Other effects of ultraviolet irradiation, such as vitamin activation, are less well understood.

Locally the effect of ultraviolet rays is twofold: First, an irritation is produced which may go on to destruction and which is followed by a benign process of restitution. Second, there is probably a specific response to chemical products of the photochemical changes occurring in the cells.

Terry [10] has recently shown that x-rays have no destructive action on the virus of herpes.

EXPERIMENTAL WORK

In the following group of experiments an attempt has been made to determine the effect of ultraviolet rays on the isolated virus, as well as on the virus in an infected cornea. It is to be noted that these experiments are concerned solely with the viricidal effect of ultraviolet rays.

As a source of radiation, an Alpine sun lamp was selected from the physical therapy department of the Massachusetts General Hospital and used throughout these experiments. This is the product of the Hanovia Chemical and Manufacturing Company of Newark, N. J., which describes its values as follows:

> The 110 Volt D.C. Alpine Sun Lamp (when new) at a distance of 50 cm. from the burner has an intensity of about 90 erg seconds per square mm. of area ultra-violet energy. The ratio of the ultra-violet intensity to the visible light intensity is about 1.1 to 1.2. The ratio of the ultra-violet intensity to the infra-red intensity is about 1.1 to 2.7. (Much of the infra-red is low temperature radiation from the heated quartz and hood.) That is, the visible light intensity is about 95 erg seconds per square mm., and the infra-red intensity is about 225 erg seconds per square mm. Since the burner is not new, the intensity is less than this, maybe two-thirds, depending on how old the burner is.

However this may be, the "skin erythema dose" became the basis of irradiation. In practically all communications I find the same true. The corneal epithelium tolerates the rays no better than the skin. In most clinics, therefore, slightly less than the erythema dose is given. In many clinics much less is used.

On a 21 year old man with light red hair and fair freckled skin the following was found: At 50 cm. distance, irradiation for five minutes gave a definite erythema which persisted four days. No desquamation

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10. Terry, T. L.: X-Rays Ineffective Against Herpes Virus, Am. J. Ophth. **2**:554, 1928.

followed. Irradiation for eight minutes gave a marked erythema with burning and itching, which persisted more than a week, and was attended by definite desquamation.

Five minutes of irradiation at 50 cm. was therefore considered the erythema dose. This is considerably higher than is used by the dermatologic department in the hospital for early treatments.

In a series of rabbits' corneas, it was found that five minutes of irradiation at 50 cm. caused a definite stippling of the epithelium, and eight minutes of irradiation a complete loss of epithelium. It took longer periods of irradiation than these, however, to cause a permanent, grossly visible scar in the cornea. At any rate, I do not believe that any one would use a larger dose on the human cornea than one which would totally abrade the rabbit cornea. It will be noted that in most of the following experiments twice this dose was used, and often more.

The source of the virus for all experiments was either from typical keratitis dendritica or from herpes labialis. Indistinguishable lesions are produced by both on rabbit corneas. The potency of the virus was not considered a factor. Attention is called, however, to the rapidity with which the active agent can disappear from the rabbit cornea, and also to the fact that it can lose a great deal of its potency toward the end of its residency in any one cornea. Experiments carried out with virus of this reduced virulence give added strength to my conclusions.

The animals used were rabbits, usually young ones from 8 to 12 weeks of age. It is known that these have a greater resistance to the virus than older animals. Separate hutches for each were used, to prevent cross-infections, such as are known to occur in common cages. Added to this was regular steam sterilization of the hutches.

Irradiation was kept as constant as possible by the use of the same Alpine lamp from day to day. A uniform distance of 50 cm. from arc to corneal surface was selected, which proved satisfactory. It was at a sufficient distance to avoid undue heating, and near enough to make the time element reasonably short.

GROUP 1.—*Destruction of Herpes Virus in Cornea Exposed to Ultraviolet Rays After Enucleation.*

In the following series of four attempts, the procedure was as follows: A rabbit with a typical corneal lesion was selected; the eye was enucleated under procaine hydrochloride anesthesia, and immediately mounted on an operating board. The cornea was kept moist with a drop of sterile physiologic solution of sodium chloride every three minutes. A control vaccination was made from the enucleated eye to a normal rabbit's cornea, and irradiation was immediately begun. At regular intervals vaccinations were made in the usual manner by cutting into the infected cornea with a sharp spud, gathering as much material as

possible, and making three parallel scratches into the cocainized normal cornea. These scratches went well through the epithelium and undoubtedly through several layers of corneal stroma. Again the spud was stroked over the infected cornea and more material applied to the recipient eye.

All animals were observed daily; particular notice was made of inflammation, any irregularity in corneal reflex, etc. Examinations were made with oblique illumination with the ophthalmoscope, and in all questionable cases, with the slit-lamp. Of these methods, ophthalmoscopic examination unquestionably gave the most reliable information. The early infiltration along the scratches with subsequent fine and later gross arborization formed a perfectly typical appearance. Mild and delayed "takes" were not unusual and were noted. Definite takes were observed two, and even three, times later than the ordinary incubation period of from twenty-four to forty-eight hours.

TABLE 1.—*Results in Group 1* *

Experiment	Age of Virus in Excised Eye, Days	Vaccinations at						
		Control	5 Min.	10 Min.	15 Min.	20 Min	25 Min.	30 Min.
1	6	+++	.....	.....	0	.....	.....	.....
2	5	+++	+++	+++	0	.....	.....	.....
3	6	+++	+++	++ d.	+++ d.	.....	.....	.....
4	4	+++	+++	+++	+++	++ d.	+++	.....

* The symbols used in this and the accompanying tables are: +++, strong take; ++, moderate take; 0, no take, and d., delayed take.

This group of attempts tended to point out:

In experiment 1 (table 1) the virus became inactivated by less than fifteen minutes of irradiation.

In experiment 2, the virus did not become inactivated by ten minutes of irradiation but did by fifteen minutes.

In experiment 3, the virus may have been somewhat attenuated by ten minutes, but was not destroyed even by fifteen minutes.

In experiment 4, the virus was still perfectly active after twenty-five minutes of irradiation.

The obvious objections to this experiment are that the virus is being irradiated on a curved surface, the cornea possibly shielding the more dependent virus from the rays. Also the possibility of contamination from unirradiated fluid beneath the globe must be remembered.

The latter must be excessively slight, as all material for transfer was taken from the uppermost corneal center. At any event, compared to the conditions of clinical irradiation, these must be ideal, for there are no fornices for hidden virus to escape irradiation and no shielding of the lids.

The chance of reinfection in this group must be comparatively a small one.

GROUP 2.—*Exposure in Vitro of the Virus of Herpes to Ultraviolet Rays.*

It is well known that herpes virus is a rather labile agent. It dies in saline solution at room temperature in a few hours. It is destroyed easily by mild antiseptics, likewise by heating to relatively low temperatures. It seems especially subject to oxidation, and conversely is preserved by a reducing agent such as cysteine hydrochloride. Under ideal conditions, however, the virus can be preserved, and certain strains have been kept active for over a year in 50 per cent neutral glycerin in a dark ice chest.

A few experiments of irradiating the virus in saline solution were attempted, but with such difficulties that blood serum, a better preserver of virus, was substituted for the saline solution.

TABLE 2.—*Results in Group 2*

		Interval of Irradiation					
Experiment	Control	2 Min.	5 Min.	10 Min.	15 Min.	20 Min.	30 Min.
1	+++	++	++	0	0	0	.....
2	+++	+++	+++	+++	.....	++	0

Accordingly the corneal epithelium of two rabbits with dendritic keratitis was scraped off under cocaine anesthesia and taken up in 0.2 cc. of fresh normal rabbit serum. This was divided into two portions, the first being set aside as a control and kept under the same conditions as the second portion. The latter was irradiated with the Alpine lamp. At intervals, vaccinations were made onto normal rabbit corneas, and after the last, a vaccination was made from the control portion.

From the first experiment (table 2) it seems that the virus became inactivated by ten minutes of irradiation; in the second, by neither ten nor twenty minutes.

GROUP 3.—*Effect of Previous Irradiation of Serum on Subsequently Added Virus.*

The question arises regarding the previous experiments as to whether or not the irradiation produces in the serum any substance which is destructive to herpes virus. It is also conceivable that the serum may undergo some proteolytic change which may be lethal to the virus. Hence this experiment was undertaken.

One cubic centimeter of clear fresh rabbit serum was placed in each of two salt cellars. The first was irradiated for thirty minutes with the Alpine lamp at 50 cm., and the second allowed to stand at room temperature for the same length of time. The virus-containing epithelium from both corneas of one rabbit was then scraped off and taken up in 0.5 cc. of the same sample of serum. This third sample containing the virus was then equally divided and added to each of the first two portions. These two were then incubated at 37 C. for half an hour and vaccinated to different eyes.

In the control eye typical corneal herpes of moderate severity developed.

The eye vaccinated with the previously radiated serum with added virus showed a typical corneal herpes of slightly less severity and slightly delayed development.

Apparently previous irradiation of the serum did not destroy the added virus, although it might possibly have attenuated it slightly.

TABLE 3.—*Results in Group 4*

Experiment	Control	30 Min. Irradiation at 50 Cm.
1.....	+++	0
2.....	+++	+++
3.....	+++	+++

GROUP 4.—*Radiation of Herpes Virus Through Blood Serum in a Quartz Cell.*

These experiments were devised as a direct test as to the penetration of actinic rays through blood serum.

A small cylindric container, 11 mm. high, was constructed. Its walls were glass from a large pyrex test tube, 3 cm. in diameter; its floor, a plate of quartz, 1 mm. thick. These were simply cemented together. In the cell was placed 2.5 cc. of clear blood serum which filled the vessel to a depth of 2.8 mm. Under the cell in a smaller salt cellar was placed the virus to be irradiated. Special care was taken so that no portion of the virus could escape from the direct irradiation through the blood serum and quartz.

The virus in each experiment was represented by the corneal epithelium from one or two rabbit eyes with active herpes keratitis taken up in 0.4 cc. of physiologic solution of sodium chloride. This was centrifugated for five minutes at rather low speed and the supernatant fluid used.

The control consisted of 0.1 cc. of this portion of virus set aside in a covered salt cellar and vaccinated to a fresh rabbit cornea after the period of irradiation of the first portion.

This experiment was repeated on three separate days, the results shown in table 3 being obtained.

The inactivation of the agent in experiment 1 was a startling and encouraging beginning for this group. It is felt, however, that the repeated negative results are much more important, especially when one considers the extreme lability of the virus. It is to be noted that the take from the irradiated portions of experiment 2 and 3 were equally as severe as the controls. An explanation for this may possibly be found in the heating effect of the lamp, even at 50 cm. To lessen this as much as possible in the subsequent experiments, the virus was placed in a bath of ice water.

GROUP 5.—*Irradiation of Herpes Virus in Saline Solution Through a Glass Plate.*

The human cornea will transmit only light waves greater than 0.295 micron in length. Louis Bell found that a crown glass cover in common

TABLE 4.—*Results in Group 5*

Experiment	Control	30 Min. Irradiation at 50 Cm.
1.....	+++	++
2.....	+++	++

use for ordinary lantern slides had practically the same transparency. It was considered important, therefore, to determine its protective value for the virus of herpes. The glass is 1 mm. in thickness.

This experiment was carried out in much the same manner as the previous one. Three-tenths cubic centimeter of the centrifugated sample of virus in saline solution was placed in a salt cellar, covered with the glass plate and irradiated at the same distance. The control was treated as already described.

In both cases the control take was slightly more severe than the irradiated one. The protection seemed perfectly definite, however, and it seems improbable that ultraviolet rays can have any abiotic effect on the virus after passing the glass plate or its parallel, the cornea.

GROUP 6.—*Irradiation of Herpes Virus in the Living Rabbit Cornea After Different Periods of Incubation.*

The following attempts were made to determine, if possible, whether or not the virus could be destroyed on the living cornea. Three rabbits were vaccinated on both corneas from the same source at different intervals, thereby giving different incubation periods to the virus in the several rabbits.

At the time of radiation the virus had been present in rabbit 1, twenty-two and one half hours; in rabbit 2, six hours, and in rabbit 3, three hours. Rabbit 1 already showed definite infiltration along the corneal scratches of both eyes.

A speculum was then inserted into the right eye of each rabbit in turn, and the eye was given a thorough lavage with sterile saline solution, in an effort mechanically to cleanse the mucous membrane. The eye was then irradiated for fifteen minutes at 50 cm.

In rabbit 1 (incubation period, twenty-two and one half hours) typical herpes keratitis continued to develop in both eyes. The signs were even more violent in the irradiated eye, as if the ultraviolet burn were simply an added insult. The later results were practically identical, in that the rabbit on the eighth day had marked leukomatous infiltration in both eyes and died of herpes encephalitis.

Rabbit 2 (incubation period, six hours) likewise continued to show a marked take in both eyes. The irradiated eye was more red and showed a greater degree of corneal infiltration than the unirradiated eye. The control eye was enucleated on the eighth day for study.

In rabbit 3 (incubation period, three hours) herpes failed to develop in either cornea. The virus apparently had disappeared from the source eye over night. The irradiated eye lost its corneal epithelium, and showed a marked ultraviolet conjunctivitis which subsequently healed without gross scarring.

It appears from these experiments that the virus-infected cornea was not sterilized by thirty minutes of irradiation after the virus had had an incubation period of six hours or twenty-two and one-half hours. In fact, the severity of the reaction in each case was augmented by the irradiation. Until the eighth and twelfth days, on which the respective rabbits died, there was no marked difference in the corneal infiltration. The possibility of reinfection of the corneal wounds from unexposed virus in the conjunctival folds and fornices must, of course, be considered, and I believe that it undoubtedly does take place. At any event, the same must occur in dendritic keratitis in human beings after treatment with the lamp.

GROUP 7.—*Irradiation of Herpes Virus in an Isolated Flake of Superficial Corneal Tissue with Epithelium Intact.*

In order to eliminate the possibility of reinfection after irradiation, the following experiment was done. A rabbit with herpes keratitis in its active stage was taken. The eye was cocainized, and with a Graefe knife a thin flake of superficial corneal tissue was removed. This was easily done, especially in large rabbits, by inserting the knife point into the corneal stroma above, with the blade held in the same plane as the corneal lamellae. Cutting downward, a strip from 3 to 5 mm. wide

and as long as the corneal diameter was removed, without perforating into the anterior chamber. (In some of the later experiments, the animals were killed before corneal flakes were removed.) The flake was immediately placed with the epithelial surface uppermost in a large drop of saline solution in the bottom of a Petri dish. The dish was placed on a cool cloth, kept moist with ice water, and irradiation was commenced at the usual distance. At intervals, fragments were cut from the flake which were ground up and vaccinated into scratches on rabbit corneas. Water lost by evaporation was replaced by small additions of

TABLE 5.—*Results in Group 7*

Experiment	Source of Virus	Irradiation				
		Control	15 Min.	30 Min.	45 Min.	60 Min.
1	Herpes labialis.....	—	++	....	....	....
2	Herpes labialis.....	++	++	++	....	....
3	Herpes labialis.....	—	—	—	....	—
4	Herpes labialis.....	++	++	++	....	++ d.
5	Herpes labialis.....	++	++	—	....	—
6	Dendritic keratitis.....	—	—	—	—	—
7	Herpes labialis.....	++	++	++	....	++ d.
8	Herpes labialis.....	+ d.	++	++	++	....
9	Herpes labialis.....	++	++	—	++	....
10	Herpes labialis.....	++	++	++	++ d.	....
11	Herpes labialis.....	++	....	++ d.	—	—

TABLE 6.—*Analysis of Takes in Group 7*

Irradiation, Minutes	Times Attempted	Number of Takes	Take, per Cent	Number of Atypical Takes
15	8	8	100	None
30	8	6	75	One delayed
45	4	3	75	One delayed
60	4	2	50	Two delayed; one light

sterile water to the drop in which the flake lay. Before irradiation, control eyes were also vaccinated from the flakes in every case.

Table 5 represents the summarized efforts. Delayed and mild takes are designated as before.

Before interpreting these results, attention is again called to the extreme lability of the virus dealt with. It is difficult to explain failures of take in the control, such as occurred in experiment 1. Immunity of the animal is possible, but highly improbable, as fresh animals were used. It is known that in rabbits, unlike human beings with herpes labialis, a short-lived immunity develops after corneal infection. This immunity may last for six months. The negativity of the control in experiment 1, of course, does not influence the deductions from this experiment. Similarly, in experiment 8, the control showed a definitely

delayed take, while the irradiated flakes gave perfectly typical takes. Experiments such as 3 and 6 were discarded entirely.

From the remaining experiments from which deductions could be made, that is, all save 3 and 6, the data shown in table 6 were obtained.

In the light of these findings, it seems clear that the destructive effect of ultraviolet rays on the virus is excessively slight. The exact site of the virus in any cornea one must assume is not definitely known. If it is in the epithelium alone, it should be destroyed more easily than otherwise; if throughout the stroma, one must conclude that it would be even more difficult to destroy it clinically, as the flakes included no more than one-half the corneal thickness.

GROUP 8.—*Fluorescein as an Augmentor of Ultraviolet Activity.*

This investigation was carried out in connection with experiments 9, 10 and 11 of the preceding group. In each case two corneal flakes were removed, one of which was dipped for one minute into a 2 per cent solution of fluorescein in a 3 per cent aqueous solution of sodium bicarbonate. This was then washed in sterile saline solution to pre-

TABLE 7.—*Results in Group 8*

Series	Experiment	Control	Irradiation			
			15 Min.	30 Min.	45 Min.	60 Min.
Control	9	++	++	—	++	..
	10	++	++	++	++ d.	..
	11	++	....	++ d.	—	—
Fluoresceinized	9	....	++ d.	—	—	..
	10	++	++	++	++ d.	..
	11	++	....	++	++	—

cipitate the dye. Controls were vaccinated from each of these flakes and irradiation begun as before. At intervals small bits were removed from each flake, ground up and vaccinated into fresh corneas.

The data in table 7 express the results of the two series. Before analyzing them, it is seen:

In experiment 9 the entire fluoresceinized group was totally or (in the fifteen minute exposure) partially inactivated, as shown by a delayed reaction. As the control, too, was inert, it would point toward either a diminished amount of virus originally present in the control flake, or a partial inactivation by the fluorescein or saline solution.

In experiment 10 perfectly equal and active takes were obtained in both series.

In experiment 11 the fluoresceinized series throughout gave more prompt takes than the controls, even up to forty-five minutes of irradiation. There was certainly no activation of the abiotic effect by fluorescein.

CONCLUSIONS

1. The foregoing experiments show conclusively that the virus of herpes cannot be destroyed in the cornea by any exposure to ultraviolet rays which would be practical to use on the human eye.

2. Staining the cornea in fluorescein does not in any way enhance the germicidal effect of ultraviolet rays on the virus of herpes.

3. If the beneficial clinical results reported in cases in human beings have been due to the ultraviolet irradiation, it has not been due to the germicidal effects of the rays, but to some unknown secondary effects. On a priori grounds such effects are highly improbable.

THE MONOCULAR MOVEMENTS

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NOMENCLATURE OF THE MONOCULAR MOVEMENTS

When one eye is excluded from vision it still regularly moves in association with its fellow, following in part, though not wholly, the laws that obtain when the two eyes are used together. One cannot properly, therefore, speak of monocular as something distinct from binocular movements. Nevertheless, the analysis of binocular movements becomes easier if one considers, first, how each eye is individually turned by the muscles attached to it. Such a consideration has the advantage that in making it one does not have to know what the other eye is doing and hence does not have to determine whether the movement of the observed eye is one of parallel action, convergence or divergence. It may be any of the three or a compound of two of them, but one does not have to decide this. I simply describe it in terms of the departure that the observed eye makes from what is called the primary position.

The primary position, which, in normal conditions, is also the position of rest, i. e., the position that the eye tends to assume when its muscles are not attempting to move it, is the position in which the visual axis of the eye is directed straight ahead (neither to the right nor the left) and horizontally. (In the true position of rest it is probably directed a little below the horizontal, but in describing the movements of the eye it is best to locate the starting point in the horizontal plane.)

The movements that the eye executes from the primary position comprise rotations about all three axes, vertical, transverse and fore-and-aft, or about some intermediate axis. From a clinical point of view, however, it is better to classify the possible movements in another way. For what chiefly interests clinicians is to ascertain the result of the movements, i. e., first, the direction in which the eye is pointing, and second, whether the eye as it turns in any given direction also rolls about its fore-and-aft axis. Movements by which the direction

† Dr. Alexander Duane died on June 10, 1926.

Mrs. Duane has courteously permitted the publication of certain chapters from the book on "Ocular Muscles," on which Dr. Duane was so industriously working and which he had nearly completed at the time of his unfortunate end. These chapters represent the views of an authority who devoted his life to scientific research in a field to which he had so ably contributed.—THE EDITORS.

of the visual line is changed are called ductions or direction movements; movements by which the eye spins about the visual line so as to tilt its vertical and transverse axis nasally or temporally are called torsions (cycloductions or wheel rotations). Ductions and torsions are subdivided as follows:

Ductions (Direction Movements)

1. Rotations about vertical axis:
   - Adduction, or rotation of eye toward nose
   - Abduction, or rotation of eye toward temple
2. Rotations about transverse axis:
   - Elevation (superduction), or rotation of eye upward
   - Depression (subduction), or rotation of eye downward
3. Direction movements produced by a combination of 1 and 2:
   - *Oblique movements*
   - *Torsions*[1] *(Cycloductions)*
4. Rotations about fore-and-aft axis (visual line):
   - Intorsion, or tilting of the vertical meridian of the eye toward the nose
   - Extorsion, or tilting of the vertical meridian of the eye toward the temple

LISTING'S LAW

Compound movements in which torsions are combined with ductions are frequent. Such a combination regularly occurs in the oblique position of the gaze, the torsion following what is called Listing's law.

Listing's law is thus enunciated by Helmholtz:

> When the line of sight passes from the primary position to any other position, the wheel rotation [torsion] of the eyeball in the second position is the same as if the eyeball had been rotated about a fixed axis perpendicular to both the first and the second directions of the line of sight.
>
> This law may also be put in the following way:
>
> When the eye passes from the primary position to any other, its torsion in the second position is that which it would get by having the corneal end of its line of sight travel from the primary position to the second directly, i. e., along the arc of a great circle.
>
> As can readily be proved trigonometrically, this means that when the eye is directed up and out or down and in, its vertical meridian is tilted outward (extorted), and when the eye is directed up and in or down and out, the vertical meridian is tilted inward (intorted).
>
> This statement, which is that of Donders, agrees also with experiments made with after-images[2] and with what is known of the actions of the muscles.

1. The term torsion was introduced by J. Le Conte (Sight: An Expression of the Principles of Monocular and Binocular Vision, New York, D. Appleton & Company, 1881, p. 177). He restricted the term to the tilting that occurs in the oblique directions of the gaze, which tilting he regarded not as a real rotation of the eye, but as an evidence of oblique projection.

2. Le Conte (footnote 1) seems to me to have fully refuted the contrary interpretations made by Helmholtz, and to have substantiated that of Donders.

The tilting of the vertical meridian produced in these oblique positions of the gaze, according to many, does not represent a true rotation of the eye about its anteroposterior axis, but is simply the result of an oblique projection. But those who so argue make, it seems to me, one essential error. They fail to recognize that the actions of the elevating and depressing muscles are such that in the oblique directions of the gaze there is not only an oblique projection, but in addition a real rotation round the visual axis producing a tilting of the vertical meridian quite in accordance with Listing's law. Thus when the eye is directed up and out, the superior rectus no longer acts to produce inward torsion and the inferior oblique works at its maximum to produce outward torsion, so that the net result is that the eye is really rolled out round its fore-and-aft axis. In any event, granting that the tilting has the character that they would ascribe to it, it still produces the same effect on the retinal and projected images that a true torsion would do, and hence, so far as the clinical symptoms are concerned, amounts to the same thing.[3]

It must not be inferred from figure 1 that the fields of action are confined precisely to the halves and quadrants as indicated. The action of the external rectus is exerted somewhat to the inside and that of the internal rectus somewhat to the outside of the midline. So also the action of the superior rectus and inferior oblique is still exerted when the eye is somewhat below the horizontal, just as the action of the inferior rectus and superior oblique is still appreciable when the eye is directed a little up. Moreover, the main action (elevation or depression) of these four muscles is by no means confined strictly to one quadrant. The more just representation of the facts is shown in figure 2. (It may also be represented schematically by figure 1, if it is supposed that each quadrant indicative of a field of action is extended vertically and laterally, so as to overlap its neighbor lying alongside and above or below; e. g., if it is supposed that the up-and-out quadrant extends laterally to *FG* and the up-and-in quadrant to *AB,* so that the two overlap over the segment *ABFG,* and it is further supposed that the up-and-out quadrant extends down to *ED* and the down-and-out quadrant up to *CB,* so that the two overlap the segment *CBDE.*) However, as a clinical fact it is important to remember that the predominating field of action of the superior rectus is the up-and-out, of the inferior oblique the up-and-in, of the inferior rectus the down-and-out and of the superior oblique the down-and-in direction of the gaze.

CENTER OF ROTATION; HOW THE EYE ROTATES

The different movements are performed about a center of rotation which, according to the researches of George, Toren and Lowell,[4] is

3. Duane, Alexander: Listing's Law: What Does It Mean and What Is Its Practical Value in Diagnosis? Arch. Ophth. **26**:497, 1897.

4. George, E. J.; Toren, J. A., and Lowell, J. W.: Am. J. Ophth. **6**:833 (Oct.) 1923.

situated 15.4 mm. behind the cornea and 1.65 mm. to its nasal side. This holds for outward rotations up to 20° and inward up to 30°. It is evident that such a rotation about an eccentric point means an actual slight displacement of the eye, the latter protruding somewhat in inward rotation and receding somewhat in outward rotation. It would also

Up and Out	A	*Up*	F	*Up and In*
SUP. RECT. *up*		up up	INF. OBL. *up*	
Inf. Obl. *out*		[*out*] [*in*]	Supt. Rect. *in*	
EXT. RECT. *out*		[*out*] [*in*]	INT. RECT. *in*	
C	B		G	
SUP. RECT. [*up*]			INF. OBL. [*up*]	
Inf. Obl. *out*		*Primary*	Sup. Rect. *in*	
Out EXT. RECT. *out*			INT. RECT. *in* *In*	
Sup. Obl. *out*		*Position*	Inf. Rect. *in*	
INF. RECT. [down]			SUP. OBL. [down]	
E	D			
EXT. RECT. *out*		[out] [in]	INT. RECT. *in*	
Sup. Obl. *out*		[out] [in]	Inf. Rect. in	
INF. RECT. [down]		down down	SUP. OBL. [down]	
Down and Out		*Down*	*Down and In*	

Fig. 1.—Monocular fields of action. The diagram represents the field of fixation divided into four quadrants. The eye is directed toward any one quadrant by an oblique movement effected by three muscles, two of which (denoted by capitals) are exerting their main action; one (denoted by lower case) is exerting its subsidiary action. The direction of the movement effected by each muscle is denoted by italics. Thus the diagram shows that the superior rectus has its field of main action when the eye is directed up and out and its field of subsidiary action when the eye is directed up and in. The reverse is the case with the inferior oblique. So also the inferior rectus has its field of main action when the eyes are directed down and out and its field of subsidiary action when the eyes are directed down and in, and the reverse is true of the superior oblique.

The diagram also shows the muscles concerned when the eye is directed straight up, straight down, straight out and straight in. In these directions certain of the effects produced are neutralized by effects set up in the opposite direction. Such neutralized actions are indicated by brackets. Thus when the eye is directed straight up, the external and internal rectus act, but neutralize each other so that the eye is not pointed either out or in. The lateral (subsidiary) actions of the superior rectus and inferior oblique also exactly neutralize each other, but the up-turning action of one reenforces that of the other, so that the eye goes straight up. When the eye is directed straight out, five muscles act, of which three are exerting their main actions and two their subsidiary actions. Of the two that are exerting their main actions, two, i. e., the superior and inferior recti, exactly neutralize each other so that the eye is carried neither up nor down, but straight out by the action of the three other muscles. Similar explanations apply for the muscles concerned in the straight down movement and the straight in movement.

mean that since each point of the cornea is turning about a center 15.4 mm. distant, each millimeter of rotation means a deflection of 3.7°.

The eye does not rotate in Tenon's capsule as it is often thought to do. Indeed, as Tenon's capsule is attached to the eye front and back, such rotations would be impossible. While, then, the capsule doubtless gives somewhat in rotations of the eyes, it must as a whole move with it. As Motais pointed out, the eye and the capsule move in an orbital socket formed by the fat and other tissues, and the socket itself is not quite fixed.

SHERRINGTON'S LAW

Every monocular—and still more every binocular—movement appears to be performed in accordance with what may be called Sherrington's law. This may be enunciated as follows:

Every ocular movement is effected by a combination of two actions: first, a contraction of the muscles that act to carry the eye in the direction that the movement is designed to effect, second, a simultaneous relaxation of the muscles that carry the eye in the opposite direction. Or, to put the matter differently, every movement is effected by the simultaneous excitation of the center that governs the movement and an inhibition of the center governing the movement in the opposite direction.

Sherrington, whose results were confirmed by Topolanski, showed that intracranial stimulation of one muscle, e. g., the external rectus, is associated with a simultaneous relaxation of its opponent, the internal rectus, and vice versa. The same is true of the centers governing the associated movements. Thus intracranial stimulation so applied as to produce contraction of both dextroverters (right external and left internal rectus) is associated with a simultaneous relaxation of both levoverters (right internal and left external rectus). Furthermore, when the right external rectus is contracted so that the right eye is turned outward, its return to the midline is effected not simply by a relaxation of the external rectus, but by a simultaneous active contraction of the internal rectus. These associated contractions and inhibitions, moreover, are entirely independent of any tension or elastic pull due to stretching of the tendons, since the contraction of one muscle that is thus associated with a diminution in tone of its antagonist still occurs when both muscles are detached from the eyeball.

Sherrington's experiments find strong confirmation in the facts deduced from a study of recent complete paralyses. In these, as is well known, the deviation and diplopia produced by abolishing the activity of a muscle are carried a considerable distance beyond the midline, showing that the abnormal relaxation of the paralyzed muscle is at once associated with an abnormal heightening of action of the unaffected antagonist.

The way in which these two factors (contraction of one muscle, inhibition of another) act in the case of a single pair of antagonists varies according to whether the eye is at the beginning or the end of the movement. This is set forth more at length later in the article, where it is shown that such a variation would produce an unevenness of action if it were not for the modifying action of the auxiliary muscles, which, as stated in the following section, cooperate in effecting the movement.

SEVERAL MUSCLES ALWAYS COOPERATE IN EFFECTING A SINGLE MOVEMENT

Every movement that the eye can make requires the combined action of from three to five muscles. This fact is set forth diagrammatically in figure 1. From this one learns that in oblique movements (up and out, up and in, down and out, down and in) three muscles are active; in straight up and straight down movements, four, and in outward or inward movements in a horizontal plane, five. That this presentation is correct seems proved by the following consideration. If one assumes that the presentation is correct and that the part played by the different muscles is as given, the consequences that, according to this assumption, would theoretically result if any single muscle were paralyzed are quite constantly realized in the case of an actual paralysis. Thus if the inferior rectus is paralyzed and the attempt is made to carry the eye straight outward, it is evident that according to the theory presented the eye, ordinarily held level by the mutually counteracting and increasingly strong pull of the superior and inferior recti, should now, owing to the unopposed pull of the superior rectus, deviate upward, and that this upward deviation should increase as the eye is abducted. This is what actually occurs in paralysis of the inferior rectus. Like corroboration holds for the assumption in all of its ramifications. One may therefore well believe that it is correct.

MUSCLES CONCERNED IN THE PERFORMANCE OF THE DIFFERENT DIRECTION MOVEMENTS AND THE WAY IN WHICH THEY COOPERATE

The direction movements possible to the eye through the coordinated action of its six muscles comprise rotations in every conceivable plane, the eye being capable of moving from the primary position directly to any secondary position, and from the latter again to any other secondary position, and in so doing may take either a direct or a sinuous course.[5] The typical direct movements from the primary position, together with the muscles concerned in the production of these movements, are shown in the following statements:

Movement Straight Out.—When the eye begins to move out from the primary position, the external rectus receives a strong stimulus and, according to Sherrington's law, the internal rectus is inhibited and

5. This may be proved by making two fine dots on a card, so close together that unless accurately fixed (i. e., if seen ever so slightly in diffusion circles) they will blend into one, and then moving the card slowly in all directions before the eye, the head remaining fixed. However the card is moved, the two dots will remain distinct, thus showing that the eye follows them in all their movements.

relaxes. At the same time that the external rectus receives its extra stimulus, all the other muscles except the internal rectus are stimulated too. The superior and inferior recti pulling, the one up and the other down, balance each other in vertical action, so that the eye does not swerve from its horizontal path but is kept steadily in it by the counteracting tension of the two muscles. Both muscles act to oppose each other in torsional action, so that the vertical meridian is held vertical. Both muscles combine to adduct the eye, so as to oppose to a moderate degree the outward movement, and doubtless by their steady pull prevent its taking place too suddenly or jerkily. The two obliques also counteract each other, so far as torsional and vertical actions are concerned, and thus also act to steady the eye in its course and prevent it from swerving up or down or from tilting to right or left. Both abduct the eye and so reenforce the action of the external rectus. In this stage of the movement their abducting action is in general about neutralized by the adducting action of the superior and inferior recti. The net result is that at the beginning of the outward movement the eye is abducted strongly by the external rectus, which is then acting at a considerable mechanical advantage, and it is simply steadied in its course by the action of the other four muscles, the superior and inferior recti, in particular, having the important effect of checks or brakes to prevent the abduction from going on too suddenly.

As the movement progresses the external rectus acts at a greater mechanical disadvantage, and, moreover, is now opposed by the increasing passive pull of the lengthening and tightening internal rectus. If these two muscles alone were acting, the outward movement would be slowed up and impeded. But, as an offset to the diminishing power of the external rectus, the abducting action of the obliques now comes more and more into play, since their action in this regard increases as the eye is abducted, and, what is more important, the counteracting adducting action of the superior and inferior recti falls off altogether. The result is that when the eye has been turned out about 30° it is carried further out not only by the external rectus, which now acts somewhat less effectively than before and begins to feel the opposing pull of the stretched internal rectus, but also by the obliques, the abducting action of which is constantly increasing and is no longer opposed by the counteracting pull of the inferior and superior recti. The eye is now kept straight in its path solely by the superior and inferior recti, which act simply to elevate and depress the eye and the opposing vertical actions of which keep pace with each other as they steadily increase. On the other hand, the vertical meridian is kept vertical solely by the opposing, equal torsional action of the two obliques.

The return of the eye from the straight out position to the midline shows a similar compensating action. Thus if the left eye has been carried far to the left, it is brought back, as has been shown, to the midline partly by the relaxation of its externus, and partly by the contraction of its internus. At the outset of this return movement, the relaxation of the strongly contracted externus, acting alone, would produce a marked effect that would be enhanced by the tension exerted by the stretched internus acting as an elastic cord. The internus too would produce a specially marked effect; because the muscle is already tense and its arc of contact with the eyeball is large. These three factors, acting thus with most efficiency at the outset of the movement, would grow less operative as the eye approached the midline, so that the eye should move fast at first and more slowly afterward. That, however, it moves with fairly even speed is doubtless effected by the interposition of other factors, namely, the contraction of the auxiliary abductors and adductors (the superior and inferior recti and two obliques).

The obliques at the outset of the return movement are still acting strongly as abductors and so check the too rapid movement. On the other hand, the superior and inferior recti have not yet begun to act as adductors and so do not help the return. As the midline is approached and the return movement is more or less checked, it is now reenforced by the increasing adductive action of the superior and inferior recti; and, moreover, the opposition to it made by the obliques becomes progressively less marked.

But, though these auxiliary muscles do tend to make the movement smoother and more uniform, it is clear that either an active movement of the eye out or a return from the one position to the midline is effected with most ease at the outset and becomes progressively more difficult as the terminus is approached. To make the movement quite even, then, a greater and greater output of energy is required as the eye nears the far-out position in abduction or the midposition on the return.

Movement Straight In.—Quite a similar cooperation of muscles obtains in inward movement. At the outset of the movement the external rectus is inhibited and relaxed and all the other muscles receive an extra stimulus. The internal rectus, acting at a considerable mechanical advantage, moves the eye strongly inward, excessive and jerky movement being prevented by the counteracting pull of the subsidiary abductors, i. e., the superior and inferior obliques. The inferior and superior recti, on the other hand, by their adducting action, which about balances the abducting action of the obliques, reenforce the inward

movement. The eye is kept from swerving up or down and the vertical meridian is kept vertical by the combined and opposing actions of the superior and inferior recti and the obliques.

When the eye is turned well in, the internal rectus, acting now at some mechanical disadvantage, is opposed mainly by the passive pull of the stretching external rectus, since the abducting power of the obliques has now become nil, and it is sensibly reenforced by the steadily increasing adducting action of the superior and inferior recti. The eye is kept from swerving up or down solely by the obliques, and its vertical meridian is kept vertical solely by the superior and inferior recti.

Movement Straight Up.—When the eye is moved straight up, the inferior rectus and superior oblique are inhibited and relaxed, and the other four muscles are stimulated. The eye is carried up by the combined action of the superior rectus and inferior oblique, the former predominating. The lateral actions of these muscles oppose each other and tend to keep the eye steady in its upward course. The like is true of the external and internal recti, which contract strongly and by their equal, opposing actions keep the eye from swerving to the right or left. The vertical meridian is kept vertical by the counteracting torsional actions of the superior rectus and inferior oblique.

Movement Straight Down.—Similarly, in a movement straight down the superior rectus and inferior oblique are relaxed, and the eye is carried down by the inferior rectus and superior oblique. The abducting and adducting actions of the latter muscles counteract each other, as do the abducting and adducting action of the external and internal recti, so that the eye is kept from swerving to right or left as it goes down. Moreover, as the torsional actions of the inferior rectus and superior oblique nullify each other, the vertical meridian is kept vertical.

Movement Up and Out.—When the eye moves up and out, the internal rectus, inferior rectus and superior oblique are relaxed. The eye is carried out by the external rectus, the movement being opposed at first by the superior rectus and reenforced by the inferior oblique. As the eye goes further out and the opposing action of the superior rectus falls away, the reenforcing action of the inferior oblique increases, so that the outward movement is hindered only by the passive pull of the stretching internal rectus. At the beginning of the movement the eye is carried up by both the superior rectus and the inferior oblique, but soon the latter ceases to act, and the superior rectus alone elevates the eye. The vertical meridian, at first really vertical, later becomes tilted outward, since the increasing torsional action of the inferior oblique is now unopposed by the superior rectus, which is acting solely as an elevator.

Movement Up and In.—When the eye moves up and in, the external rectus, inferior rectus and superior oblique are relaxed. The eye is carried in by the internal rectus, the movement being opposed by the inferior oblique and reenforced by the superior rectus. As the eye goes further in, the reenforcing action of the superior rectus increases and the opposing action of the inferior oblique falls away, so that the inward movement is opposed only by the passive pull of the lengthening external rectus. The eye is carried up at first by the superior rectus and inferior oblique together, later by the oblique alone. The vertical meridian is tilted in, because the increasing torsional action of the superior rectus predominates more and more over the decreasing torsional action of the oblique.

Movement Down and Out.—When the eye moves down and out, the internal rectus, superior rectus and inferior oblique are relaxed.

TABLE 1.—*Torsions of the Eye (Cycloductions)*

Direction of Vertical Meridian	Muscles Concerned	Acting When Eye Is Directed
Straight (vertical)	Superior and inferior oblique	Straight out
	Superior and inferior rectus	Straight in
	Superior rectus and inferior oblique	Straight up
	Inferior rectus and superior oblique	Straight down
Tilted in (intorsion)	Superior rectus Superior oblique	Up and in Down and out
Tilted out (extorsion)	Inferior rectus inferior oblique	Down and in Up and out

The eye is carried out by the external rectus, assisted more and more by the superior oblique and counteracted to a decreasing extent by the inferior rectus. It is moved down at first by both inferior rectus and superior oblique, later by the former muscle alone. Its vertical meridian is tilted in by the increasingly predominant torsional action of the superior oblique.

Movement Down and In.—When the eye moves down and in, the external rectus, superior rectus and inferior oblique are relaxed. The eye is carried in by the internal rectus, assisted more and more by the inferior rectus and counteracted to a decreasing extent by the superior oblique. The eye is carried down at first by both inferior rectus and superior oblique, later by the superior oblique alone. The vertical meridian is tilted outward by the increasingly predominant torsional action of the inferior rectus.

Torsional Movements.—These are shown in table 1.

MUSCLES CLASSIFIED ACCORDING TO ACTION

It is thus seen that there are three abductors of the eye, the external rectus and the superior and inferior obliques; three adductors, the internal rectus and the superior and inferior recti; two elevators, the superior rectus and the inferior oblique; two depressors, the inferior rectus and the superior oblique; two intorters, the superior rectus and the superior oblique, and two extorters, the inferior rectus and the inferior oblique.

It is also seen that in the primary position and also in looking straight up, straight down, straight in and straight out there is no torsion; in looking up and in and down and out there is intorsion; in looking up and out and down and in there is extorsion.[6]

DISTINCTIVE DUCTION MOVEMENTS; THE SIX DIAGNOSTIC DIRECTIONS OF THE GAZE

From a consideration of the foregoing facts and particularly of figure 1, it is evident that in movements straight in or straight out five muscles cooperate, in movements straight up or straight down, four, and in oblique movements, three. In movements straight up the superior rectus and inferior oblique both act to raise the eye. If in this direction of the gaze the eye fails to rise as well as usual, one of the two muscles must be at fault, but one cannot tell which, since both are here acting together. If, however, a deficiency in elevation is noted when the eye is carried up and out, it must be ascribed to a failure in the superior rectus, since this is the only muscle acting to elevate the eye in this quarter of the field. Similarly, any failure in elevation when the eye is directed up and in must be due to deficient action of the inferior oblique. So too, a failure of the eye to descend when directed down and out would indicate an insufficiency of the inferior rectus, and failure to descend when directed down and in, an insufficiency of the superior oblique. Thus movements in the four oblique directions of the gaze give, when impaired, distinctive evidences of trouble, which are not afforded by impairment of the movements straight up or straight down. They are therefore called diagnostic directions. Also classed as diagnostic directions are movements straight in and straight out. For, though in looking straight out five muscles cooperate and three of these act in producing lateral rotation, yet by far the greatest part of this rotation is effected by the external rectus, so that a deficiency of any amount in moving outward must be attributed to insufficiency of this muscle. Similarly, any marked disturbance of movement straight inward must be attributed to a deficiency of the internal rectus. Accordingly, it may be

6. This has been proved by experiments with after-images.

said that, corresponding to the six muscles of the eye, there are in monocular vision the following six diagnostic directions of the gaze:

Muscle	Diagnostic Direction
External rectus	Out
Internal rectus	In
Superior rectus	Up and out
Inferior oblique	Up and in
Inferior rectus	Down and out
Superior oblique	Down and in

This states a fact of fundamental diagnostic importance.

FIELD OF MONOCULAR FIXATION

By ascertaining the limits of excursion of the eye in all directions, the boundaries of the field of fixation are defined. The field of fixation represents that portion of the space that can be seen by central fixation without moving the head.

The measurement of the field of fixation in any given case requires that the patient under examination shall, in each excursion that he makes with his eyes, put forth the maximum effort of which he is capable. This he will frequently fail to do, thereby making the field appear incomplete. It is only by making several examinations and taking the maximum of all the measurements that one arrives at a perfectly reliable result, i. e., one that shows the full extent of excursion of which the eye is capable. The discrepancies thus obtained in repeated examinations are well shown in cases 1, 5 and 6 of the following summary (table 2), which is constructed from observations of my own, made on normal eyes with the perimeter, and using the fine double dot as a test object. The figures in some cases may be slightly too large, since the head was not rigidly fixed in these experiments, but I do not believe that the excess in any instance could be over 5°.

The average of the observations tabulated gives rather a larger field of fixation than has been obtained by other experimenters. Thus Landolt's figures, while showing a close agreement for excursions in the upper field, are appreciably less for movements downward (about 50° in looking down, 38° in looking down and out, and 47° in looking down and in). On the other hand, the experiments of Schuurmann and Donders give the range of downward excursion as 57°, which is somewhat less than those that were found by me, but the upward excursion as only 34°. This latter figure certainly seems too small, in view of the fact that in but one of my cases was the range as low as this, and that in nearly all the others it fluctuated between 40 and 50°.

The limits of the field of fixation, as a matter of fact, probably vary rather widely in normal subjects.

I believe that one may be warranted in saying that in average subjects the extreme movements of the eye are from 50 to 60° inward, outward and downward and from 40 to 50° upward. This would mean that the total vertical sweep of the eyes is almost 100°, and the lateral sweep 110°. In certain cases these limits may be exceeded.

One must distinguish between the field of fixation and the field of excursion. The field of fixation is often cut off in places by the nose or the overhanging brow, so that, especially in directions up and in and

TABLE 2.—*Measurements of the Field of Fixation*

Case	Up	Up and Out	Up and In	Out	In	Down	Down and Out	Down and In
Right Eyes*								
1 1st examination.....	40	35	40	35	40	70	35	25
2d examination.....	38	45	40	48	48	42	55	50
2.....	40	50	40	..	..	45	60	60
3.....	50	45	55	55	45	60	65	55
4 Right eye not examined								
5 1st examination.....	40	48	(50)	60	(50)	62	65	(50)
2d examination.....	40	48	(55)	50	(55)	(62)	50	(60)
3d examination.....	(30)	42	(42)	50	(45)	60	65	(60)
6 1st examination.....	32	45	32	52	52	..	65	50
2d examination.....	38	..	50	..	..	..	..	..
7.....	32	35	35	55	52	72	65	(62)
8..	44	55	55	60	60	62	70	(65)
9.....	50	50	60	52	(60)	80	(70)	60
10.....	40	40	42	50	42	45	50	40
11 1st examination.....	47	50	50	40	63	63	67	55
12 Right eye not examined								
13.....	45	55	(55)	50	60	55	52	(53)
14 1st examination.....	52	60	55	52	50	62	60	55
2d examination.....	40	50	(45)	65	(50)	65	80	(50)
15.....	(50)	45	52	48	56	62	58	(60)
16 1st examination.....	52	50	55	48	56	60	60	(50)
17 1st examination.....	40	38	50	40	(45)	68	(65)	(50)
2d examination.....	47	52	52	48	(48)	60	(40)	60
18.....	60	70	62	75	60	65	73	60
Left Eyes*								
1 1st examination.....	50	40	45	35	45	70	60	50
2d examination.....	42	40	55	48	60	70	50	60
2.....	40	50	40	..	..	60	50	60
3.....	35	40	45	55	50	65	..	75
4.....	40	38	46	48	40	35	38	32
5 1st examination.....	40	52	42	53	[48]	65	70	[50]
2d examination.....	43	50	[44]	52	48	[68]	62	[48]
3d examination.....	42	50	40	48	[50]	65	60	[50]
6 Left eye not examined								
Left eye not examined								
7.....	35	42	45	55	52	70	65	60
8 Left eye not examined								
9.....	55	60	60	58	60	72	75	[40]
10 Left eye not examined								
11 1st examination.....	50	45	55	47	60	65	68	60
12.....	50	60	50	50	[60]	70	62	[40]
13.....	[40]	55	50	50	[50]	60	75	..
14 1st examination.....	46	60	55	55	45	72	72	60
2d examination								
15.....	48	50	50	56	55	65	50	[60]
16 1st examination.....	48	55	52	55	52	60	55	52
17 1st examination.....	40	42	[50]	40	62	70	60	[52]
18 2d examination.....	44	50	50	48	[50]	62	62	[40]
	58	71	71	72	62	72	76	68

* Figures enclosed in parentheses and brackets mean that at this point the test object disappeared from view behind some projecting part of the face, but at the time of disappearance was still within the field of fixation.

down and in, the object of regard is hidden from view and the eye can no longer fixate it. However, the eye can often still follow the object beyond the boundaries of vision provided the other eye still fixates and follows it. Its limit of excursion, therefore, is greater than its limit of fixation. From a clinical point of view the former is much more important to determine than the latter.

PART TAKEN BY EACH MUSCLE IN PERFORMING DUCTION AND TORSION MOVEMENTS; FIELD OF ACTION OF INDIVIDUAL MUSCLES

The part taken by each muscle in performing duction and torsion movements is shown graphically in figure 2. Reference to this will, I believe, materially facilitate the analysis of the complicated problems involved in the study of the movements of the eyes.

The figure represents the field of fixation of a normal eye having a rather extensive power of motion.

C represents the projection of the extremity of the line of sight (point of fixation) when the eye is in the primary position; *D*, *E* and *O*, its projection when

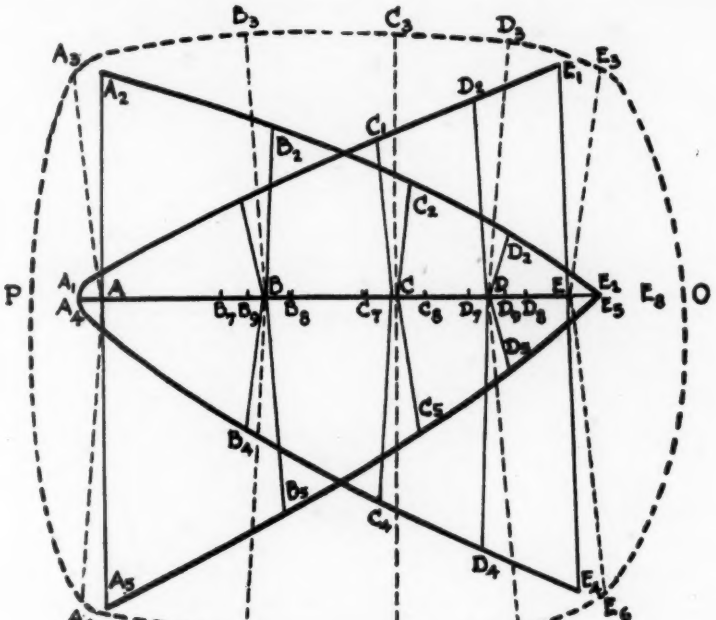

Fig. 2.—Projection of fixation of the eye and of the field of action of each of the ocular muscles. (From Duane, Alexander: A New Classification of the Motor Anomalies of the Eye Based upon Physiological Principles, Together with Their Symptoms, Diagnosis and Treatment, New York, J. H. Vail & Company, 1897.)

the eye is abducted 18, 25 and 45°, respectively; *B*, *A* and *P*, projection when the eye is adducted 20, 45 and 50°, respectively. The distance *CO* represents the maximum degree of excursion of the eye outward. Most of this movement is effected by the external rectus, but a certain portion, especially toward the outer end of the excursion, is accomplished by the united action of the two obliques. The distance *CP* represents the maximum range of excursion of the eye inward. Thus inward movement is effected mainly by the internal rectus, assisted especially toward the end of the excursion by the superior and inferior recti.

The lines AA_1, BB_1, CC_1, DD_1 and EE_1 represent the amount and direction of the movement produced by the superior rectus when the eye is, respectively,

adducted 45° (A); adducted 20° (B); in the primary position (C); abducted 18° (D), and abducted 25° (E). The lines AA_2, BB_2, CC_2, DD_2 and EE_2 represent the amount and direction of the movement effected by the inferior oblique, and the dotted lines AA_3, BB_3, CC_3, DD_3 and EE_3, the movement effected by the inferior oblique and the superior rectus acting together. Similarly, the lines AA_4, BB_4, CC_4, DD_4 and EE_4 represent the lines of action of the inferior rectus; AA_5, BB_5, CC_5, DD_5 and EE_5, those of the superior oblique, and AA_6, BB_6, CC_6, DD_6 and EE_6, those of the two latter muscles combined. The heavy lines $A_1B_1C_1D_1E_1$ and $A_4B_4C_4D_4E_4$ represent the limits of the fields of action of the superior and the inferior recti, respectively, and the heavy lines $A_2B_2C_2D_2E_2$ and $A_5B_5C_5D_5E_5$, the limits of the fields of action of the inferior and the superior obliques. The heavy dotted line $A_6PA_3B_3C_3$, etc., represents the limit of the field of fixation.

It will be seen from the diagram how the vertical (elevating and depressing) action of the superior and inferior recti increases, and how the vertical action of the obliques decreases progressively as the eye is carried from a position of marked adduction (A) to one of moderate abduction (E). It will also be apparent how the lateral action of each of these muscles diminishes as its vertical action increases, so that the adductive power of the superior and inferior recti shows a progressive diminution, and the abductive power of the two obliques a progressive increase as the eye passes from A to E. That is, at A (i. e., when the eye is adducted 45°) the superior and inferior recti have no vertical action at all, but simply adduct the eye through a comparatively large extent, while the two obliques have no lateral action at all, but simply elevate and depress the eye. At E, on the other hand (when the eye is abducted 25°), the two recti no longer act as adductors at all, but simply elevate and depress the eye, and the two obliques no longer exert any vertical effect, but combine to carry the eye outward, their abductive action here being particularly great.

At A the superior rectus and the inferior oblique, acting together to their full extent, will carry the eye up and noticeably inward (to A_3), since here the adductive action of the rectus is at its maximum and besides is not balanced by any opposing abductive action on the part of the oblique. Similarly, at E the two muscles acting together will carry the eye upward and noticeably outward (to E_3). In intermediate positions, as at B and D, the lateral action of one muscle will partially counteract that of the other, so that the net lateral effect will be less. For example, at B the adductive action of the superior rectus is less than it was at A and, moreover, is now opposed by a moderate abductive action on the part of the inferior oblique, so that the net adductive effect is but slight. The eye, therefore, here is carried up by the inferior oblique, assisted somewhat by the superior rectus, and is also carried slightly inward (to B_3). At D, on the contrary, it is carried upward mainly by the superior rectus, assisted somewhat by the inferior oblique, and is also carried slightly outward (to D_3), by the preponderating lateral (abductive) action of the latter muscle. At C (the primary position) the adductive action of the superior rectus balances the abductive action of the inferior oblique, and hence the effect of the two elevators acting together will be to carry the eye straight upward.

In a similar way the inferior rectus and the superior oblique, acting together, will carry the eye down and in (AA_6, BB_6), down and out (DD_6, EE_6) or straight down (CC_6), according to whether the eye is already adducted, abducted or in the primary position.

The superior and inferior rectus, acting together with just sufficient force to neutralize each other's vertical action, will combine to adduct the eye, the adducent effect being forcible at A ($= AA_1 + AA_4$), and diminishing gradually to E, where

it is zero. At E, therefore, i. e., when the eye is abducted 25°, the inferior and superior recti, acting together, will produce no movement and hence in this position are direct antagonists.

Similarly, the superior and inferior obliques, acting together, neutralize each other's vertical action, but combine to abduct the eye. The abducent effect is marked at E ($= EE_2 + EE_5 = EE_3$), and diminishes progressively to A, where it is zero. In the latter position, therefore, i. e., when the eye is adducted 45°, the two obliques, acting simply to elevate and depress the eye, respectively, are direct antagonists.

The four muscles, superior and inferior recti and superior and inferior obliques, acting together with the force required to neutralize each other's vertical action, will produce a lateral effect varying with the amount by which the eye is already abducted or adducted. Thus, if by the action of the internal rectus the eye is already adducted 45° (to A), a position in which the obliques exert no lateral action at all, the total effect of the four muscles will be to carry the eye quite a little distance further inward (nearly to P). If the eye is adducted only 20° (B), the resultant action of the four muscles will be the difference between the adductive action of the two recti (BB_7) and the less marked abducent action of the two obliques (BB_3); i. e., the eye will be adducted slightly (to B_3). At C (the primary position), the abducent action of the obliques balances the adducent action of the superior and inferior recti, so that the contraction of the four muscles will cause the eye to remain stationary. At D, on the contrary, the abductive effect will preponderate somewhat, and the eye already abducted 18° by the external rectus will be carried still further moderately outward (to D_3). At E, i. e., when the eye is abducted 25°, the abducent effect is still more pronounced ($= EE_3$).

It is thus apparent that if all four muscles act together they will, if the eye is being adducted or abducted, tend to carry it still further in the direction in which it is going. They will, therefore, reenforce the external rectus in abducting and the internal rectus in abducting the eye, and the amount of the reenforcement will increase in proportion as the eye is already abducted or adducted. So that the internal rectus, for example, when it begins to contract (i. e., is just leaving the primary position at C), will receive little or no aid from the contraction of the other four muscles, but, as it continues to act (e. g., at B), will be more and more assisted by them, and finally when it reaches the limit of its contraction (at A) and is consequently working at a mechanical disadvantage, will be strongly reenforced.[7] In like manner the external rectus will, as its own efficiency diminishes with the increasing abduction of the eye, be assisted more and more by the simultaneous contraction of the other muscles. And it is altogether probable that it is in this way that the outward and inward excursion movements of the eye are rendered regular and uniform.

The diagram may also be used to illustrate the torsion occurring in different directions of the gaze. That is, the line BB_1 may be taken to represent the fact

7. It may be noted that the action of the superior and inferior recti in compensating for an increasing feebleness of the internal rectus is shown in another way also. The internal rectus, as L. Weiss has pointed out (Arch. f. Augenh. **29**:298, 1894), acts very much more feebly when the divergence of the orbits is great, i. e., when the orbits are shallow and the eyes far apart. But it is under just these conditions that the superior and inferior recti act to most advantage as adductors, since the greater the divergence of the orbits the greater the angle that the line of action of these two muscles makes with the anteroposterior axis of the eye, and the greater consequently is the lateral effect that they are able to exert.

that when the eye is adducted to B, the superior rectus tilts the vertical meridian quite strongly inward (as BB_1 is inclined). So BB_2 shows that in the same position the inferior oblique tilts the vertical meridian slightly outward, and BB_3 shows that both elevators, acting together, tilt the meridian moderately in. Again, the fact that CC_3 is strictly vertical shows that when the eye is in the primary position not only is it carried straight upward by the combined action of the two elevators, but its vertical meridian also remains vertical during the ascent.

It will also be observed that the combined action of the superior and inferior recti or of the superior and inferior obliques, or of all four muscles together will be not only to keep the eye in the horizontal plane (in the line OP), but also to keep its vertical meridian from rotating either to the right or to the left, as the eye is carried outward or inward. Similarly the other facts regarding torsion in the various directions of the gaze are indicated by the lines BB_6, DD_3, etc.

MECHANICAL ADVANTAGES IN THE EXISTING PLAN

The distribution of forces produced by the existing arrangement of the muscles is such as to produce a smooth, even movement in any given direction. It has just been pointed out how the action of the elevators and depressors reenforces the action of the external and internal recti, keeping the eye from deviating up and down when performing a lateral movement and also reenforcing that movement at the point where it tends to become feeble.

The arrangement for effecting elevation and depression presents a similar advantage. By the action of the opposing external and internal recti and also by the lateral actions of the elevators and depressors themselves, the eye is steadied in its upward or downward course and prevented from swerving to right and left.

In oblique movements, the fact that the failing power of one elevator or depressor is compensated for by the increasing power of the other makes for smoothness of movement and maintenance of the eye at a constant level. If, for example, the superior rectus were the only elevator of the eye, then in certain positions of the gaze it would be acting at a mechanical disadvantage and the eye would tend to drop. But, as it is, when the eye reaches the position where the superior rectus begins to fail, the inferior oblique comes in to supplement its action and enables the eye to be kept with ease on a constant level above the horizontal plane. The advantage of this supplementary force is particularly evident in binocular vision. For if the superior recti alone were acting and their anatomic relations were the same as at present, then when the eyes were directed up and to the right the muscle of the right eye would be acting at an advantage and that of the left at a disadvantage, so that the left would drop and diplopia would result.[8]

8. Such diplopia, in fact, occurs. Thus in a paralysis of both superior obliques the two inferior recti, acting together, while effecting single vision in looking straight down, will cause vertical diplopia in the left and right lower corners of the field.

But the supplementary action of the inferior oblique, increasing in the left eye and diminishing in the right, renders the elevating action uniform in the two eyes no matter how they are turned.

AMOUNT OF WORK DONE BY EACH MUSCLE

The amount of work done by each muscle may be gathered approximately from the measurements of the excursions in different directions.

Thus when the eye is abducted 25 or 30° and is at the same time elevated to its fullest capacity, the entire work of elevation is done by the superior rectus. In this up-and-out direction the eye can move about 50°. From this it may be deduced by a simple calculation that here the elevation of the eye above the horizontal plane is about 42°. At this point, or somewhat further out, the superior rectus is working at its best as an elevator, and, in fact, is performing but little besides elevation. Hence it may be said that the total elevating power of the superior rectus is about 42°. By a similar consideration, the total depressing power of the inferior rectus may be calculated as about 48°.

When the eyes are directed straight up, the elevating power of the superior rectus and the depressing power of the inferior are less than in the eyes-out position. The difference probably amounts to several degrees. The inference is corroborated by the findings in cases of paralysis, which indicate that of the total elevation (from 40 to 50°) possible when the eyes move straight up from the primary position, from 5 to 10° are effected by the inferior oblique, leaving perhaps 35 or 40° for the superior rectus. So too, for the inferior rectus the depressing power when the eye is carried straight down is probably 40 or 45°.

The maximum elevating or depressing power of the obliques is not so easily made out, but there is every reason to think from the results of the paralysis that the vertical action of the inferior oblique equals that of the superior rectus, so that though it is only 5 or 10° in the primary position, it is 40° in extreme adduction. Similar figures apply to the superior oblique the depressing power of which varies from about 10° in the primary position to nearly 50° in extreme adduction.

The adducting power of the internal rectus cannot be so readily determined, since as it nears the limit of its action it is reenforced by the superior and inferior recti. It may be conservatively estimated that the superior rectus, if acting alone, might rotate the eye inward 50°. Similarly, the external rectus, if not aided, as it really is, by the obliques, may carry the eye out 40 or 45°.

It must be added, however, that these so-called maximum effects do not represent the absolute maximum power of the muscles. When the opponents are weakened; or even without this (e. g., in marked cases of concomitant squint), the eye can be rotated a good deal (from 10 to 15°) further in or out than here noted.

PART TAKEN BY HEAD MOVEMENTS IN SUPPLEMENTING DUCTIONS

As has been seen, the eye can make considerable movements in all ductions by virtue of the muscles attached to it, so that the boundaries of the field of excursion are from 45 to 55° from the position of rest. These are the boundaries if an extreme movement is performed. But in all ordinary ways of looking these extreme movements of the eyes, which are straining and disagreeable, are avoided, being replaced in large part by movements of the head. Generally speaking, indeed, it is the head that initiates the movement, performing what may be called the coarse adjustment, and the eye then completes the process, making the fine adaptations that place it in the perfectly fixing position. Thus when an object on the right excites one's attention, one involuntarily turns the head toward it, and when it is pretty nearly straight before the eye, one turns the eye till the image of the object falls on the fovea.

Fischer[9] found, from the examination of six hundred cases, that under conditions of natural vision most persons could move the eyes only 12° before calling in supplementary movements of the head. In many the range was less than this; in one only was it more.

FIELDS OF ORDINARY AND FORCED EXCURSION

Owing to the fact just stated, that movements of the head largely replace those of the eyes, the ordinary field of excursion of the eye is quite limited, extending not more than from 10 to 12° in any direction. The limits here are those set by sensations derived from easy, unforced seeing.

Opposed to this is forced excursion, when one gazes suddenly to one side or suddenly down. Movements of this sort may double the ordinary field. The limits here are fixed by the rather sharp sense of strain produced by the sudden effort.

By movements made to the limit usually possible, as when the field of fixation is taken with the head immobilized, one arrives at the field of extreme excursions. In general, the limits are between 40 and 50°, these being fixed by the tension of the opposing muscles, presumably normal.

Finally, in conditions of squint the field of excursion may be enlarged in some directions, and to as much as 70 or 80° inward and outward, something like 70° downward and 50° upward.[10] This is the

9. Arch. f. Ophth. **95**:49, 1922.

10. In extreme deviations of this sort the cornea may be almost completely buried beneath the inner canthus in a lateral deviation or may be quite hidden by the lower lid in a case of extreme downward squint. Refer to what is said on this point by H. Rønne (Verhandl. d. auss. Tagung d. ophth. Gesellsch., Wien. 1921).

field of extraordinary excursions, the extent of which is limited only by the check ligaments.

The distinction here made is not unimportant clinically. One may, for example, have insufficiencies of muscular action that are so slight that they cause no restriction of movement and hence no tendency to diplopia within the limits of the ordinary field of excursion. Such insufficiencies are demonstrated only when one determines the excursions to their extreme limits. Nevertheless, these moderate insufficiencies, which give no evidence of their presence in the ordinary field, not infrequently cause trouble and require attention. On the other hand, in cases of marked paralysis in which there is diplopia over the whole field of fixation, an operation that restores single vision or even makes the diplopia comitant within the ordinary field of excursion may be of considerable help, although in the peripheral field there is still double vision.

IRIS INCLUSION OPERATION IN THE EYE OF THE RABBIT

A HISTOLOGIC STUDY

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The literature relative to the various operations for iris inclusion is extensive. It is, however, almost wholly concerned with the clinical aspects of this operation on man. The results, as discussed, are compared with other filtering operations. The *raison d'être* for its continuation as a logical surgical attack is almost universally based on its apparent clinical results in lowering the glaucomatous tension. Some histologic studies have been made on eyes that have been enucleated after this operation. Naturally, these studies have usually been made on those eyes in which the operation was a failure, though histologic studies have also been made in certain cases in which the operation had continued to be successful over a period of several years.

Holth recently presented observations based on a study of three eyes enucleated after death. In these he dealt with the histology of fistulas following anterior sclerotomy. Holth presented, on two different occasions, microscopic studies of fistulas. In January, 1922, in *The British Journal of Ophthalmology,* he presented six cases of subconjunctival fistulas with photomicrographs showing scars from five months to six years after successful iridencleisis. In August, 1931, in the ARCHIVES OF OPHTHALMOLOGY, the three cases mentioned previously were illustrated with photomicrographs showing fistulas after anterior sclerotomy wherein the scars were at least three years old. In this last paper all of the operations were combined with iridectomy without any trace of iris inclusion.

No attempt will be made in this article to include even a brief review of all the work that has been presented. It seems sufficient to give this alone as a bibliography. (An ophthalmologic review of the literature is much needed in order to correlate the work of the various authors and investigators as to surgical indications, procedure, histopathology and the clinical results obtained.)

Read before the Section of Ophthalmology, Philadelphia College of Physicians, Jan. 22, 1932.

From the Peter Ophthalmological Clinic, University of Pennsylvania Graduate School of Medicine, and the Laboratory of Surgical Research, University of Pennsylvania School of Medicine.

EXPERIMENTAL WORK

The following study was carried out at the recommendation of Dr. Luther C. Peter and with his advice.

A series of rabbits were used for the experimental work. One was held throughout as a control, and a second as an iridectomized control wherein a simple iridectomy was done early in the study. Two others were held as pathologic controls wherein a secondary or postiritic glaucoma developed as the result of repeated paracenteses of the anterior chamber followed immediately, each time, by an injection of 5 per cent sterile saline solution into the anterior chamber. A plastic iritis occurred with hypertension, with atrophy of the iris and with partial seclusion of the pupil.

The other rabbits were operated on, in part, with iridencleisis, and, in part, with iridencleisis combined with the smallest possible iridodialysis. The purpose of this investigation was to study the eye microscopically after iris inclusion to determine, if possible, solutions for the following problems:

1. The rôle that the iris epithelium may play in the filtration.
2. The rôle that the iris stroma and the iris endothelium may play in the filtration.
3. The histologic appearance of the bleb at various periods after operation, three months, six months, from nine months to twelve months, and still later if thought necessary.
4. The anatomic and mechanical reasons for a filtering cicatrix.

and to attempt to formulate:

5. An opinion regarding this operation as a "proper surgical procedure," or to find reasons why it should not be given such a valorization, and
6. General conclusions and a summary of the operation. (This, of course, would be a personal opinion based on the studies made.)

All the surgical work, including most of the routine determinations of the ocular tensions at various ages, was done after the intraperitoneal injection of sodium amytal in amounts up to 60 mg. per kilogram of body weight, as suggested by Ravdin. At the time of the enucleation, in each instance, the final tension was taken before the rabbit was killed and while under the anesthetic. After the enucleation, the rabbit was killed with chloroform.

For all surgical work, the animal's head was fixed in a Palmer head holder, and the four limbs were strapped in a spread eagle fashion. Tonometry was done throughout with the same Bailliart tonometer. No infections resulted. In the largest percentage of cases, the lids were sutured following the operations, and were not reopened until the sutures had either become untied spontaneously or had sloughed through the margins. Conjunctival sutures were used in the majority of cases.

In a few instances in which very large conjunctival flaps were obtained, conjunctival sutures were not thought necessary. Postoperatively, mild silver protein and atropine sulphate were instilled as is customary and orthodox until the eyes became white.

The operations were all done within two weeks, except in the instance of the pathologic controls. One of these was operated on in the third month. The other was never operated on. In all cases the enucleations were done in the third, sixth and ninth months after the operations.

Of the other eleven rabbits used, simple iridencleisis was performed on five and this same operation combined with iridodialysis was done on the remaining six. The technic used was that of flap elevation, keratome incision, eversion of the iris and its withdrawal, a meridional iridotomy and the necessary completing sutures. In those with iridodialysis, this was done by grasping the iris near its root, detaching it the least possible amount, then proceeding with eversion and incarceration of the iris as in the foregoing instances. In each case the tension of the two eyes was taken so the eye not operated on would be a constant control against its mate on which operation was performed. All operations were done under rigid asepsis.

It was realized that this study concerned eyes that were wholly normal as to tension, as well as without those anatomic changes that may develop in the glaucomatous eye as a result of or coincident with ocular hypertension. For this reason, certain criticism may be made as to the value of these studies. This paper, however, is not primarily a study of clinical results in the reduction of ocular hypertension; such a purpose is only coincidental to this investigation. The causation of artificial glaucoma is a difficult process, and when once present is of such an artificial and secondary nature that surgical treatment for its relief is rather complex, doubtful and uncertain, and quite different from the mechanics undoubtedly involved in so-called primary glaucoma, whether acute or chronic, inflammatory or noninflammatory. Conclusions, therefore, must be based on a study of normal rabbit's eyes with normal tension, plus, however, the microscopic anatomy as it may be found. It seems that this explanation should answer the aforementioned possible objections.

After enucleation, the eyes were fixed in formaldehyde solution, embedded in paraffin, sectioned and stained.[1] Most of the staining was done with hematoxylin-eosin. A few were stained for the study of scar tissue.

1. Dr. Perce DeLong, pathologist at the Wills Eye Hospital, sectioned these eyes. Further, he assisted me in the examination of approximately three hundred sections cut from these eyes.

The tension of the control rabbit on which operation was not performed remained throughout from 20 to 22 mm. of mercury. The tension of the first pathologic control rose from 17.5 to 25 mm. of mercury, then dropped to 23 mm., and when it was killed the tension was 26 mm. of mercury. The tension of the second control into which the injections were made rose from 23 to 25 mm. of mercury, after the operation held at 24 mm. of mercury for two months, and was 19 mm. of mercury when it was killed. The tension of the iridectomized eye, which was 22 mm. of mercury before the operation, dropped to 15 mm. one month later, then rose to 16 mm. of mercury and remained there until the animal was killed in the sixth month.

I am inclined to think that the anesthesia used in these rabbits played some undetermined rôle in the tension readings and tension errors. It seems logical that variations in the degree or depth of anes-

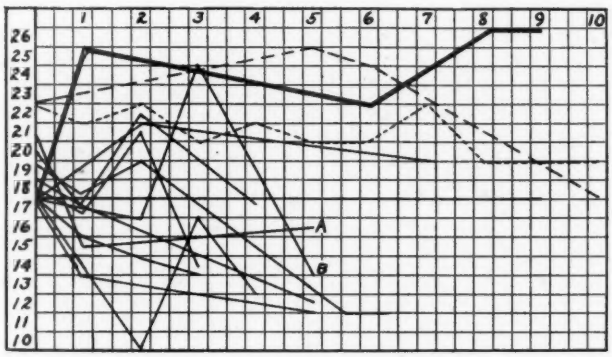


Fig. 1.—Graph showing tension in all cases. The double line represents the tension curve of the iritic glaucomatous eye on which operation was not performed; the dotted line, the tension curve of the absolute control; the dashed line, the tension curve of iritic glaucomatous eye on which operation was performed. *A*, the tension curve of the iridectomized eye.

thesia would manifest itself in a rise or a fall of tension. Further, rabbits vary greatly in their reaction to sodium amytal, and no method has been found to overcome this variability.

Attention is first called to figures 1 and 2. It is rather interesting as well as unexplainable that the eye of the iridectomized control (see tension curve *A*) should have had a fall in tension, considering that the anatomy of the eye was absolutely normal. The microscopic sections showed that this result did not occur from the operation so far as a filtering cicatrix was concerned. An instance almost as bizarre, however, is the curve *B* wherein, following an iridencleisis, the tension rose in the third month to 25 mm. of mercury and then dropped rapidly in the fifth month to 14 mm. of mercury. In curve *A*, figure 2, plotted as the average of all the cases, one can see that the tension after the

operations fell, to rise again almost to that present before the operation, then once more to fall and again to rise, so that at the end the tension was practically the same as it had been before any operation was performed. The average of the right eyes not operated on (a control for each individual rabbit) was 19 mm. of mercury, while the final averaged tension of all the left eyes on which operation was performed was 15 mm. of mercury. The average tension of all the rabbits' left eyes before the operations was also 19 mm. of mercury, while the averaged tension in the same eye of all the rabbits (excluding the controls) was 18 mm. of mercury. This is to be expected, as was suggested before, in that normal eyes have been considered. The dotted line repeated in figure 2 has a curve practically parallel to that averaged curve of the eyes on which operation was performed. The ascending tension curve of the iritic glaucomatous eye not operated on opposes rather well,

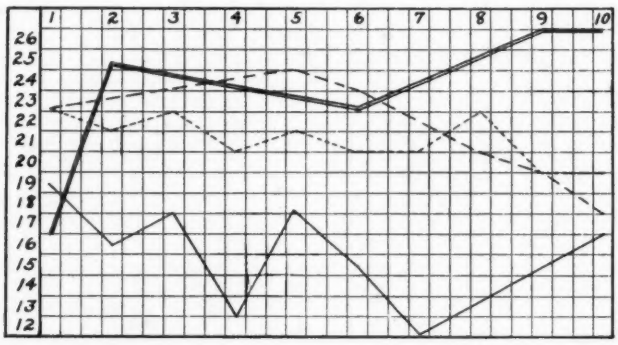


Fig. 2.—The heavy line is the original curve of all eyes on which operation was performed excepting the tension of the iritic glaucomatous eyes. The other lines in the figure are the same as in figure 1.

and as one would hope and expect, the descending tension curve of the second iritic glaucoma following the operation in the fifth month. Figure 3 is a graphic representation of the blebs that appeared. In two of the cases, including the one in which iridectomy was performed, no bleb occurred; in seven there was a small bleb and in four, a large bleb. It is rather interesting also that rabbit L-2, whose tension rose abruptly to 25 mm. of mercury after the operation to drop later to 14 mm., was described at the time of the enucleation as having a large flat bleb. The bleb of the iritic glaucomatous eye on which operation was performed when enucleated was also described as being a large flat bleb but with a shallow anterior chamber. It seems after observing these cases as if a small flat bleb is more to be desired than a large one. It is impossible to prearrange the size of this bleb. Some cases in which a large conjunctival flap was made showed small blebs, and in certain cases with small conjunctival flaps, there was a large bleb. The blebs

are considered as they appeared at the time of the enucleation. While it may have been an artefact, still those cases in which iridencleisis was combined with iridodialysis seemed to show larger blebs than did those in which a simple iridencleisis was done. One can see this at a glance in the chart.

Figure 4 records the following complications and the sequelae: severe, moderate and slight to none.

HISTOLOGIC STUDY

A study of the histologic specimens illustrated herein follows:

Figure 5 *A*: This illustration shows the normal anterior chamber angle of a rabbit. The epithelium is composed of about five layers of

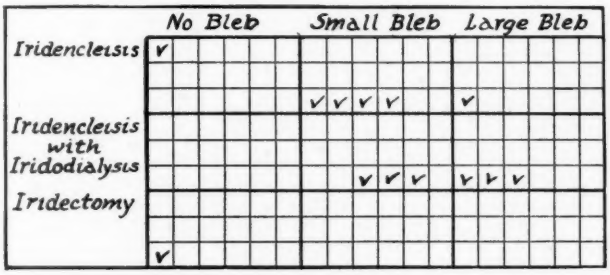


Fig. 3.—Graphic representation of the blebs as they appear at the time of enucleation.

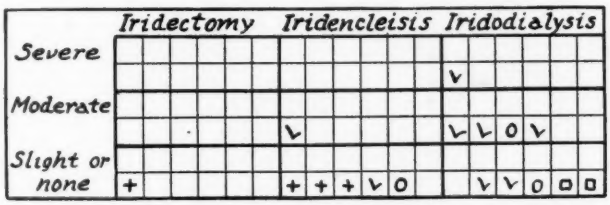
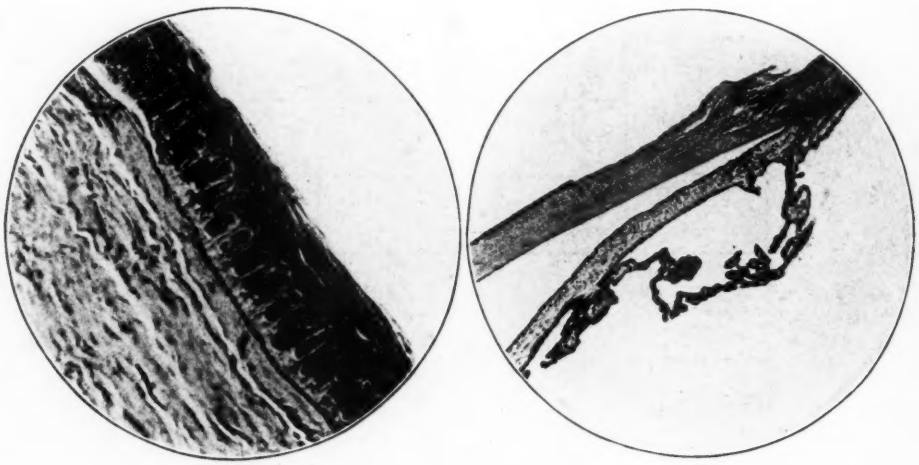


Fig. 4.—Complications and sequelae. One check indicates operative hemorrhage; two checks, iritic (delayed whitening of the eye and some atrophy of the iris); the circle, shallow anterior chamber; the square, keratitis (stripped), and the cross indicates a wholly uneventful operation and recovery. One can see that in some cases more than one of these complications have occurred. Iridencleisis when combined with iridodialysis showed most operative hemorrhage (none was found occurring postoperatively) and some postoperative stripped keratitis.

cells; the basal cells are of a longer rectangular shape than in man, standing erect on their shortest diameter. Bowman's membrane, while present, is much less distinct than in man. The corneal stroma has much of the structure of the human cornea. Descemet's membrane is much larger and more prominent than in man, and the endothelial cells seemed more elongated.

Figure 5 *B*: The corneal filtration angle is quite free. The ciliary processes are rather small, but they extend backward in a curve toward the posterior surface of the iris, where they are attached or continuous with the iris epithelium, thus forming distinct spaces between themselves and the posterior surface of the iris. The continuation of these ciliary processes on the posterior surface of the iris is the reason why in the other specimens there seems to be so much ciliary process incarceration with the iris incarceration. The two structures are practically one anatomically.

Figure 6 *A*: The epithelium shows some edema, especially in the cell bridges. There is some desquamation of the superficial epithelial cells. The superficial layers of the cornea show some edema in that there is a



A B

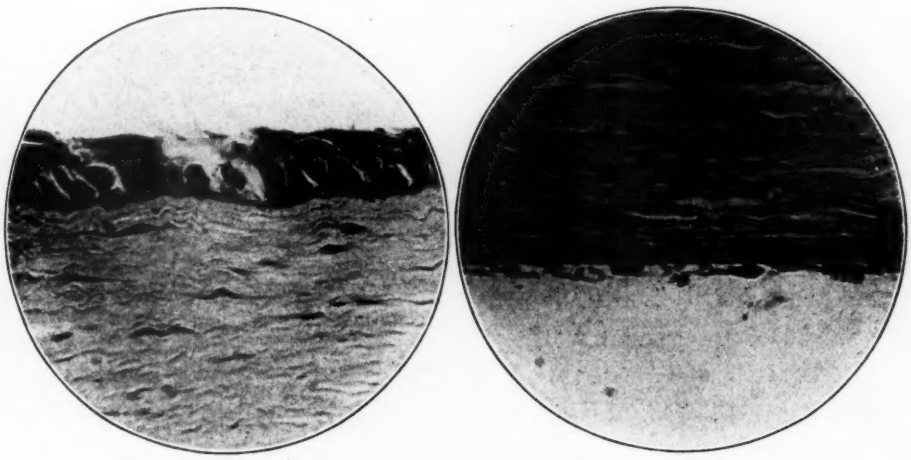
Fig. 5.—*A*, epithelium near the normal anterior chamber angle (limbus) of the rabbit's eye. (See text for details of description.) *B*, normal anterior chamber and filtering angle of normal rabbit's eye.

stained coagulum lying between the layers. In other sections of the epithelium examined, especially those near the bleb, there was a moderate degree of round cell infiltration between the epithelium and the cornea with many embryonic connective tissue cells, also, with new blood vessels, most of which consist of simple endothelial tubes. The epithelium, early, had a tendency to increase in thickness to six or seven layers of cells. Later this thinned out again to the normal thickness.

Figure 6 *B*: The posterior surface of the cornea shows an unchanged Descemet's membrane. There is some edema as serum or serous exudate lying on the endothelial cell layer. The deeper layers of the cornea themselves show a coagulum lying between the layers. Some of the endothelial cells contain pigment in large clumps as well as in smaller particles. There is little if any round cell infiltration on the posterior

surface of the cornea. In some of the sections the cut ends of Descemet's membrane were curved and folded on themselves. In general, the corneal epithelium showed some few temporary early changes with quick return to the normal. The cornea itself showed much coagulum between the corneal layers. This seemed to remain very long, being present even in sections of nine months' duration. The pigment on the posterior surface of the cornea and in the endothelial cells was very slow of resolution. It did, however, disappear almost wholly in the later specimens, though some could always be found.

Figure 7 *A*: The optic nerve specimen shows some slight edema of the nerve head with some wrinkling of the retina, which might be of postmortem origin. There is some slight separation of the fibers of the



A B

Fig. 6.—*A*, corneal epithelium following iridencleisis; the section was taken some distance from the limbus. Desquamation of epithelium, edema in the cell bridges and some serous exudate between the layers of the corneal stroma itself are shown. *B*, the posterior surface of the cornea following iridencleisis. See the text for detailed description of changes herein.

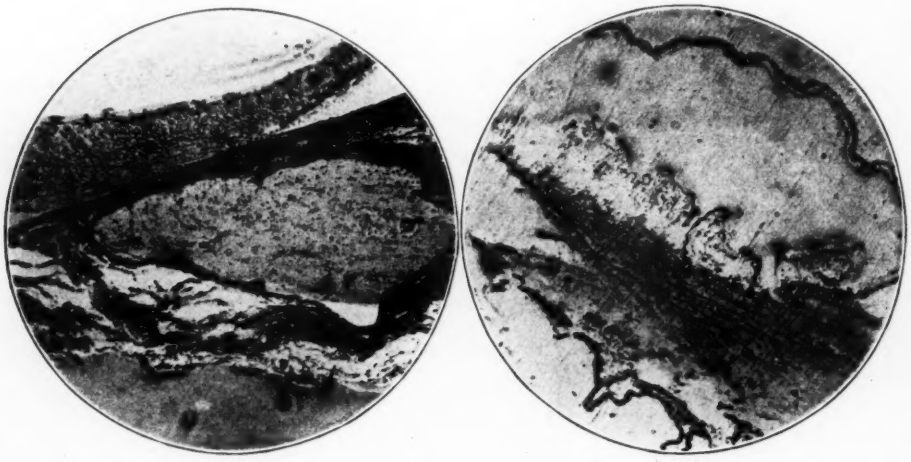
nerve in the nerve head as well. This also might be a postmortem change. There is no round cell infiltration. The nerve head is practically normal.

Figure 7 *B*: A large filtering bleb which has separated itself from the sclera by reason of the contents of this bleb is shown in this section. These contents are a serofibrinous pink-staining coagulum with fibrin bands on the sclera, which have an appearance of trabeculae or of palisades. The epithelium overlying the bleb has from two to three more layers than is normal in the rabbit. One can see how the coagulated contents of the bleb have become shrunken through fixation so that there is a slight space between the surface of this coagulum and

the under surface of the epithelial outer wall. The illustration shows rather well the slight tissue block which lies between the intra-ocular tissues and all extra-ocular influences. The section itself is unfortunately poor from a microscopic standpoint, but nevertheless it illustrates well the minute anatomy of a bleb.

Figures 8, 9, 10 and 11 show a serial group of the fistulas thirteen days after the operation, three months, six months and nine months.

Figure 8 *A* and *B*: These sections are the high and low power magnifications of a simple incarceration of the iris. The section selected for photography was slightly lateral to the appearance of the iris above the sclera at the corneal scleral junction. It illustrates rather well the thin space that is appearing between the incarceration and the contiguous



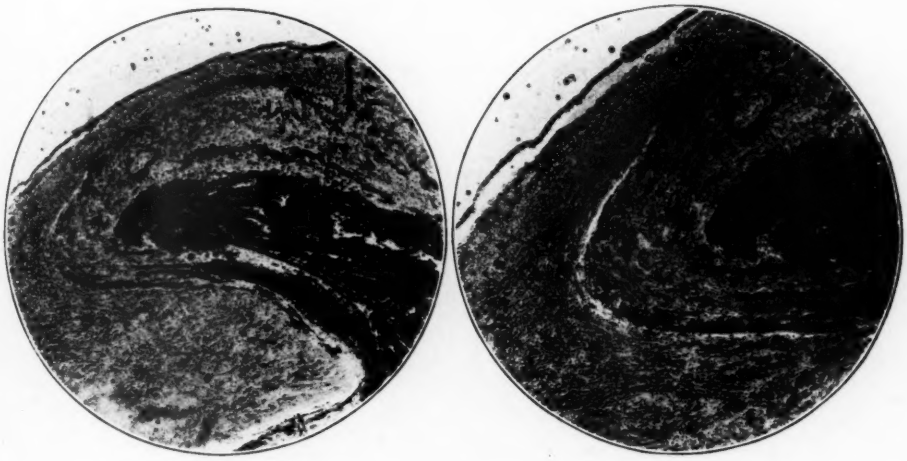
A B

Fig. 7.—*A*, optic nerve following iridencleisis. *B*, section of a large filtering bleb. See the overlying epithelium, coagulated mass in the bleb and the trabeculae or fibers that lie upon the sclera at the base of this coagulum.

cut surface of the sclera. This is the first stage in the formation of the fistula. The iris shows early evidences of degeneration manifested by the migration of its pigment and a moderate degree of edema. The stroma of the iris lies anterior to the layer of pigmented epithelium in the section as if the apex of the incarceration was present here. Other sections from the same eye showed the region where the incarceration resulted in the layer of pigmented epithelium presenting itself outermost, not wholly an eversion of the iris tissue but also a presentation of pigmented epithelium alone with an absence of overlying iris stroma. This was present near the edges of the incarceration. As stated, this stroma is separating itself from the adjacent layers of the sclera by a definite space. The section shows some embryonic connective tissue cells in small numbers with but few newly formed blood vessels. The

migration of pigment is beginning to appear in the upper outermost layers of the iris stroma as well as in the deeper layers and above in the sclera. This rabbit died spontaneously thirteen days after the operation (cause undetermined), with but little if any elevation of the conjunctiva above the spot of subconjunctival pigment and iris.

Figure 9 *A*: The cornea is negative for any pathologic process. The filtration angle on the opposite side was free save for a bit of coagulated serum exudate. The filtration angle at the iridotasis shows a definite obliteration of the angle. The tissue there is composed of organized connective tissue. The tissue or area that forms the cystoid cicatrix is filled in with the base of the iris containing many cystic spaces produced by the pigmented epithelium. The walls are made up of organized con-



A B

Fig. 8.—*A*, low power magnification of a section of thirteen day old incarceration. *B*, high power magnification of *A*. Early pigment changes, edema of the incarcerated mass, its early degeneration. Its separation from the edges of the contiguous sclera are shown. See text.

nective tissue which contains blood vessels. This incarceration plug seems to be connected with the posterior and vitreous chambers of the eye. The iris is healthy except that it contained many degenerated pigmented epithelial cells. There is some incarceration of the ciliary body as well. (See section of the normal iris and ciliary body of the rabbit.) There is considerable proliferation of fibrous connective tissue with the formation of many new blood vessels in and about the ciliary body. Many of the newly formed blood vessels in the ciliary body have rather thick walls.

Figure 9 *B*: This section is a high power magnification of the same eye showing better the thin-walled new blood vessels lying in the incarcerated stroma. Some of these contained blood cells. The changes in

the pigmented epithelium as well as the deposition of the connective tissue is well shown in this section.

Figure 10 *A*: This section shows a typical cystoid cicatrix. The iris lies between the clean clearcut edges of the sclera. It is large and degenerated, showing thin-walled and thick-walled blood vessels with loose pigment lying between the various tissue cells. There are many large, pigmented epithelial cells, most of them with a full normal complement of pigment, with organized connective tissue fibers, and with some round cells. There was a definite humping of the entire cystoid cicatrix above the level of the sclera. This entire mass has considerable pink-staining coagulum lying between the loose layers and elements incarcerated. It is interesting to note that the larger spaces as they are

A B

Fig. 9.—*A*, the incarcerated mass passes through the sclera cut showing well the marked early pigment changes; the cut end of Descemet's membrane is quite evident. The split in cornea anterior to the incarceration is an artefact from fixation. This section is cut three months after the incarceration. *B*, section from same eye showing the large number of early thin-walled blood vessels.

forming are all lined with pigmented epithelial cells and with considerable newly formed connective tissue.

Figure 10 *B*: A higher power magnification of the same section shows a bit of the round cell infiltration in the sclera and in the incarcerated mass, the ragged migration of the pigment granules and the many newly formed blood vessels.

Figure 11 *A* and *B*: These photomicrographs are of a typical cystoid cicatrix showing the definite manner in which the pigmented epithelium maintains the wall of the cicatrix both anteriorly as well as posteriorly. Immediately beneath the layer of the pigmented epithelium is the

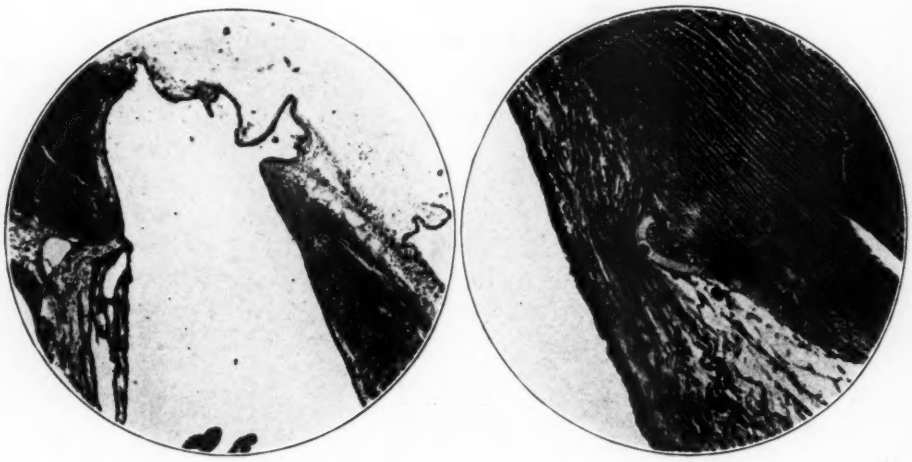
atrophic iris tissue and the connective tissue deposited therein. The high power magnification shows distortion of the layers of the cornea, the solid incarceration of Descemet's membrane, the very few thick-walled blood vessels remaining and the rather solid line of pigmented epithelium, atrophic iris and connective tissue. This is a portion of the anterior wall of this fistula. The bleb above, as seen with the low power magnification, starts at the cornea by an elevation of the epithelium there, and is continued in the section but very faintly. Even the roof of this bleb has pigment deposited therein. One can see a group of very thin-walled lymph spaces in the anterior portion of the bleb. There seems to be no round cell infiltration in the sections. The tissue reaction is rather similar to that of an old plastic iritis.

A B

Fig. 10.—*A*, section from an eye six months after operation. Further changes have occurred in the mass. The changes are given in detail in the text. The cystoid cicatrix is well illustrated in its formation to that of the final appearance of this filtering cicatrix. *B*, high power magnification of same section as *A*. Notice the changes in the epithelium of the bleb, blood vessel formation and changes in the pigmented epithelium.

When these last four are considered as a group, especially when comparing the low power magnifications, it seems as if the formation of a bleb depended on the incarceration of tissue in the presence of some round cell infiltration; atrophy and a cystoid degeneration of the incarcerated mass; a new thin-walled blood vessel formation, which is replaced by a few more nearly normal appearing blood vessels; a further progressive atrophy of the inclusion mass, and the development of a lining layer to the fistula of the pigment cells from the uveal pigmented epithelium. A thickening of the epithelium occurs overlying

the incarceration; some edema of the corneal epithelium remains, and there is a development of large thin-walled lymph spaces in the region of the bleb. As the age of the bleb advances, the filtering connected cystoid spaces, which have appeared early in the life of the inclusion, become more pronounced. It may be that the normal (or pathologic) intra-ocular pressure has as much to do with this atrophy as any other of several possible factors. Further, the presence of the aqueous may hold down the formation of granulation tissue. The intra-ocular pressure present, the aqueous, the primary edema of the incarcerated mass, the round cell infiltration, the epithelial nature of the tissue and the pinching of the mass between the lips of the scleral incision are all factors to be



A B

Fig. 11.—*A*, final appearance of a filtering cicatrix. See the formation of thin-walled spaces lying beneath the epithelium at the anterior portion of the bleb, with beginning reflection of the epithelium on this. The epithelium-lined walls are evident. Some pigment remains in the sclera as well as in the corneal stroma. *B*, high power magnification of *A* to show the anterior wall of the cicatrix. The atrophized iris stroma with the incarcerated end of Descemet's membrane is thus evident.

considered in the development of this cystoid cicatrix and rearrangement of tissues there.

The histologic changes, recapitulated, which have appeared in the various sections studied are: atrophy of the ciliary processes, at times quite pronounced; a more or less considerable mass of cell débris in the anterior chamber angle opposite to that of the incarceration; round cell infiltration, though this was never marked; thickening of the epithelium with some desquamation of its superficial layers; edema of the epithelial bridges, some edema of the corneal layers themselves, and some changes on the posterior surface of the cornea, not pronounced, though often

present and often permanent or at least of very long standing. Some pigment granules are deposited permanently in the contiguous cornea and sclera. Certain transient changes which appear in the corneal epithelium include a more or less temporary increase in the number of the layers of the epithelial cells. The retina and nerve head appear normal, as does the choroid excepting in the neighborhood of the ciliary body. Here, too, there appears round cell infiltration, new vessel formation and some pigment changes but no atrophy, unless one includes therein the atrophy of the ciliary processes. An atrophy occurs in the incarcerated mass with marked cystic degeneration of the iris; only a few round cells appear; there is a formation of thin-walled blood vessels, which later are followed by blood vessels with thicker walls and of a smaller caliber, also much fewer in number; spindle cells and newly formed connective tissue appear; marked changes are seen in the pigmented epithelium; generalized migration of this pigment occurs, lining the fistula with this pigment and with pigmented epithelium.

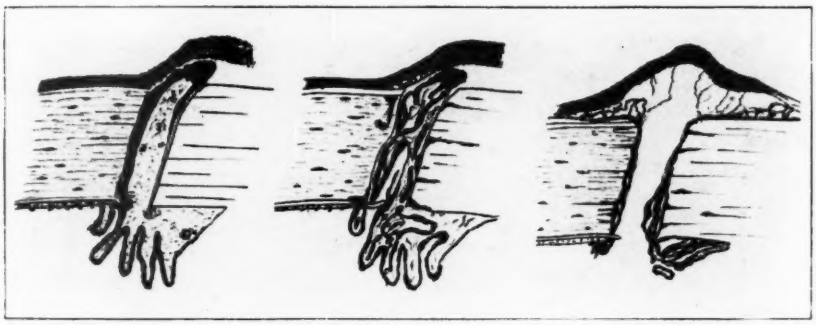


Fig. 12.—Drawing to illustrate diagrammatically the manner in which the cystoid cicatrix is formed; the mass incarcerated undergoes degeneration until that stage seen in figure 11 appears.

The diagrammatic sketches in figure 12 are presented to illustrate the development of the fistula. In the first of these three the mass might act with a wicklike drainage of the anterior chamber. In the second, while the same thing may continue, there is a beginning atrophy of the incarceration with the development of large pigment-lined spaces —all more or less connected with each other and with the anterior chamber angle. In the third there is the completed pigmented epithelium-lined fistula with its overlying bleb, the slight edema of the corneal layers which probably is not permanent though present for a long time, and the dilation of the subconjunctival lymph spaces. This atrophy occurs rather rapidly. The drawings attempt to illustrate this progression and readjustment of the tissues.

CONCLUSION

The five problems and the conclusions considered in the introduction to this essay may be discussed as follows:

1. The iris epithelium plays a most definite rôle in the process of infiltration. Its presence is absolutely essential toward maintaining a permanent fistula. It is perhaps desirable, in iridencleisis, that the epithelial layer be presented outermost and conserved *ad maximum*. It is not possible to state definitely, however, whether a complete eversion of the surface of the iris should be done in the operation. It seems that the presence of the normal iris pigment and the normal iris stroma are sufficient for the development of the fistula through the corneoscleral incision, regardless of the manner or the method in which these tissues are incarcerated.

2. The iris endothelium plays no rôle in the filtration. The stroma of the iris is considered in 1.

3. The histologic appearance of the bleb and the fistulas at various ages has been presented in figures 8, 9, 10 and 11. It seems that in general the final histologic appearance of a filtering cicatrix is approximately the same regardless of whether it resulted from an iris inclusion, from an anterior sclerotomy or even from a corneoscleral trephining. It appears that of the three, the mass of tissue lying in the keratome incision line and which must undergo atrophy, as illustrated (a condition not present in corneoscleral trephining or in sclerotomy), must influence to a certain extent the immediate results of the operation so far as a decrease in the intra-ocular tension is concerned. The later results depend, in all types of fistulas, on the development of a pigment-lined cicatrix as pointed out by the various authors. This has been demonstrated by those men interested in sclerotomy as well as by those men working with the histology of corneoscleral trephining fistulas.

4. The fourth problem has already been answered. The filtering cicatrix is due to the pigmented epithelium of the iris permanently deposited on the edges of the incision passing through the corneoscleral junction. This pigmented epithelium-lined tissue connects the anterior chamber at its angle with the subconjunctival spaces.

5. From a histologic basis alone, the operation seems to be a proper surgical procedure, in that it forms a permanent filtering cicatrix or fistula. Its permanent results, however, I feel must of necessity be somewhat delayed as compared with the abrupt and dangerous results of a sclerotomy or the more quiet and perhaps more rational results of a trephining. I feel that this fistula will remain open permanently and will thus compare favorably with the duration or age of similar cicatrices of the other operative procedures without developing a secondary closing

nonfiltering cicatrix. There is a doubt whether iridodialysis, though it simplifies the amount of incarceration, plays any important rôle in the permanent results. It does make possible an early eversion of the iris, but the immediate hemorrhage that occurs is an unwanted complication.

6. Ease of performance is a delusion, for iridencleisis is not a simple operation when done correctly. The cases in which it is done should be well selected. The degree of hypertension is a deciding factor, the condition of the lens another, the chronicity of the case a third, the age of the patient another; even the skill of the operating surgeon is a factor in deciding the operation to be used in any given case. The patient must cooperate with the operator. Postoperative attention must be detailed and rigid. The clinical result obtained in operating for glaucoma must continue to remain the final criterion as to the type of operation used. Each case is an individual problem and must be considered as such from the standpoint of therapy, i. e., no single procedure can apply. It seems that the armamentarium is still quite insufficient rather than superabundant, and everything at one's command has its place in the treatment of this *bête noire* of ophthalmology. I feel justified in repeating the last statement, almost a truism when applied to glaucomic surgery, simply because of the subject matter presented herein. I hold no brief for iridencleisis, but from a histologic standpoint it cannot be lightly dismissed.

BIBLIOGRAPHY

Allport, F.: Iridotasis in Glaucoma, Illinois M. J. **33**:155 (March) 1918.

Bader, C.: Sclerotomy in Glaucoma, Internat. M. Cong., London **3**:98, 1881.

Bell, G. H.: Iridotasis for Primary and Secondary Glaucoma, Arch. Ophth. **3**:194 (Feb.) 1930.

Bentzen, C. F.: Ueber Iridencleisis antiglaucomatosa Holth, Arch. f. Ophth. **74**: 259, 1910.

Blaickner, J.: Iridencleisis, Ztschr. f. Augenh. **72**:265 (Oct.) 1930.
Ueber Iridentkleisisoperationen, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **48**:299, 1930.
Iridencleisis, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **48**:299, 1930.

Borthen, Johan: Arch. f. Augenh. **65**:42, 1909.

Butler, T. H.: Iridincleisis, Tr. Ophth. Soc. U. Kingdom **46**:353, 1926.

Calhoun, F. P.: Reese-Holth Operation for Glaucoma, South. M. J. **20**:721 (Sept.) 1927

Capra, L.: Filtering Cicatrices Preferable to Iridectomy, Gior. di med. mil. **77**: 208 (April) 1929.

Denig, R.: Iridotasis, Ophth. Rec. **23**:6, 1914.
Iridencleisis, Klin. Monatsbl. f. Augenh. **79**:559, 1926.
Operative Method for Formation of Fistula of Iris, Arch. f. Ophth. **125**:156, 1930.

Dunn, J. S.: Iridotasis for Glaucoma, New Orleans M. & S. J. **78**:10 (July) 1925.

Dupuy, Jules: Iridotasis for Glaucoma, South. M. J. **21**:267 (April) 1928.

Gjessing, H. G. A.: Zentralbl. f. d. ges. Ophth. **21**:313, 1928.

Ultimate Outcome After Holth's Iridencleisis for Glaucoma, Norsk. mag. f. lægevidensk. **84**:1039 (Dec.) 1923.

Results of Iridencleisis by Holth's Method, Norsk mag. f. lægevidensk. **88**:737 (Sept.) 1927.

Further Investigation with Results of Iridencleisis, Operations by Holth's Method, Particularly as Regards the Method Combined with Meridional Iridotomy, Acta ophth. **15**:149, 1927.

Results of Iridencleisis, Tr. Ophth. Soc. U. Kingdom **47**:358, 1927.

Holth's Iridencleisis Antiglaucomatosa: Follow-Up Examination of One Hundred and Twenty-Two Eyes, from Six to One Hundred and Fifty-Nine Months After Operation, Arch. Ophth. **6**:489 (Oct.) 1931.

Goldenburg, M.: Iridotasis Operation for Glaucoma, Am. J. Ophth. **6**:353 (May) 1923.

Iridotasis Operation: Deduction After Eight Years, Illinois M. J. **53**:101 (Feb.) 1928.

Greenwood, A.: Combined Iridencleisis and Sclerectomy for Chronic Glaucoma, Am. J. Ophth. **13**:301 (April) 1930.

Harrower, D.: Arch. Ophth. **42**:486, 1913.

Five Years' Experience with Iridotasis, Arch. Ophth. **47**:37 (Jan.) 1918.

Herbert, H.: Ophth. Rev. **22**:234, 1903.

An Improved Iris Prolapse Operation for Glaucoma, Brit. J. Ophth. **4**:216 (May) 1920.

Present Trend in Glaucoma Operations: Iris-Prolapse Technique, Arch. Ophth. **51**:203 (May) 1922.

Iris-Inclusion Operation, Tr. Ophth. Soc. U. Kingdom **46**:326, 1927.

Future of Iris Inclusion, Brit. J. Ophth. **14**:433 (Sept.) 1930.

Holth, S.: Ein neues Prinzip der operativen Behandlung des Glaukoms, Ber. ü. d. Versamml. d. ophth. Gesellsch., 1906, p. 123; ibid., 1913, p. 222.

Iridotasis, Brit. J. Ophth. **4**:13, 1922.

Anatomical Examination of Six New Cases of Subconjunctival Fistula Scars from Five Months to Six Years After Successful Iridencleisis, or Limbal Sclerectomies in Chronic Glaucoma, Brit. J. Ophth. **6**:10 (Jan.) 1922.

Iridencleisis with Meridional Iridotomy in Acute Glaucoma, Klin. Monatsbl. f. Augenh. **79**:620 (Nov.) 1927; Norsk mag. f. lægevidensk. **88**:1156 (Nov.-Dec.) 1927.

Iridencleisis cum iridotomia meridionali, Arch. Ophth. **4**:803 (Dec.) 1930.

Ikonomopoulos, A. A.: Experience with Antiglaucomatous Iridencleisis, Klin. Monatsbl. f. Augenh. **77**:669 (Nov.) 1926.

Löhlein, W.: Review of the Literature, Zentralbl. f. d. ges. Ophth. **22**:1 (Sept. 3) 1929.

Lundsgaard, K. K. K.: Conjunctival Flap in Sclerectomy and Iridencleisis, Acta path. et microbiol. Scandinav. (supp. 3), 1930, p. 269.

Odeneal, T. H.: Comparison of Results of Elliot Trephine Operation and Iridotasis on Same Patient, Ann. Ophth. **26**:601 (Oct.) 1917.

Pillat, Arnold: The Holth's Operation, Zentralbl. f. Ophth., 1927, p. 348.

Experience with Holth's Iridencleisis: Sixty-One Cases, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **46**:70, 1927.

Post, L.: Subconjunctival Iridectomy, Am. J. Ophth. **13**:21 (Jan.) 1930.

Ræder, J. G.: Cyclodialysis Combined with Subscleral Iridencleisis, Acta ophth. **6**:390, 1928.

Roy, Dunbar: Iridotasis, Ophth. Rec. **25**:129 (March) 1916.
Late Infections After Operation for Glaucoma, Arch. Ophth. **47**:42 (Jan.) 1918.

Stieren, E.: Iridotasis, Ophth. Rec. **26**:57 (Feb.) 1917.

Verhoeff, F. H.: Histological Findings After Iridotases, Arch. Ophth. **45**:5, 1916.
Iridotasis, Improved Method, and After Iridectomy, Am. J. Ophth. **7**:373 (May) 1924.

Wilder, W. H.: Some Observations on Iridotasis in the Treatment of Glaucoma, J. A. M. A. **81**:2096 (Dec. 22) 1923.

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DEVELOPMENT OF THE HUMAN CORNEA

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During the last twenty years there have been two views of the development of the human cornea. Nussbaum [1] supported the theory of Kölliker, that following the detachment of the lens vesicle the cells of the head mesoderm grew into the space between the ectoderm and the lens. This layer increased in thickness and then split into two portions, the anterior zone becoming the cornea, and the posterior layer forming the pupillary membrane and mesodermal portion of the iris. Descemet's mesothelium then appeared at a later stage and formed the posterior boundary layer of the cornea. As recently as 1928, Mann [2] in "The Development of the Human Eye" supported this view. Figures 1 and 2 illustrate the chief steps in the corneal development according to this view.

In figure 1, the lens has separated entirely from the surface ectoderm and lies in the optic cup. The head mesoderm has grown over the margins of the optic cup and completely filled the space between the surface ectoderm and the lens. There has also been a growth of mesoderm into the optic cup around the lens. No trace of Descemet's mesothelium can be seen in this section.

In figure 2, a cleft is present, separating the mesodermal layer into the anterior or corneal portion and a posterior or pupillary membrane. The space between the two is the anterior chamber.

That these pictures do not represent the true state of affairs will be demonstrated later. This appearance of the mesodermal layer between the surface epithelium and the lens is due to the manner of sectioning the embryo, for they have been cut obliquely instead of transversely. It was on the evidence of such sections that the foregoing theory of the development of the cornea in man rested until recently.

Seefelder [3] first stated that in human beings there can be no discussion of the splitting of a common primordium into the cornea and pupil-

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From the Carnegie Embryological Laboratory and the Wilmer Ophthalmological Institute.

1. Nussbaum, in Graefe-Saemisch: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, Wilhelm Engelmann, 1912, vol. 7, p. 56.

2. Mann, Ida: The Development of the Human Eye, New York, The Macmillan Company, 1928.

3. Seefelder: Das menschlich Auge, Leipzig, Wilhelm Engelmann, 1911, p. 14.

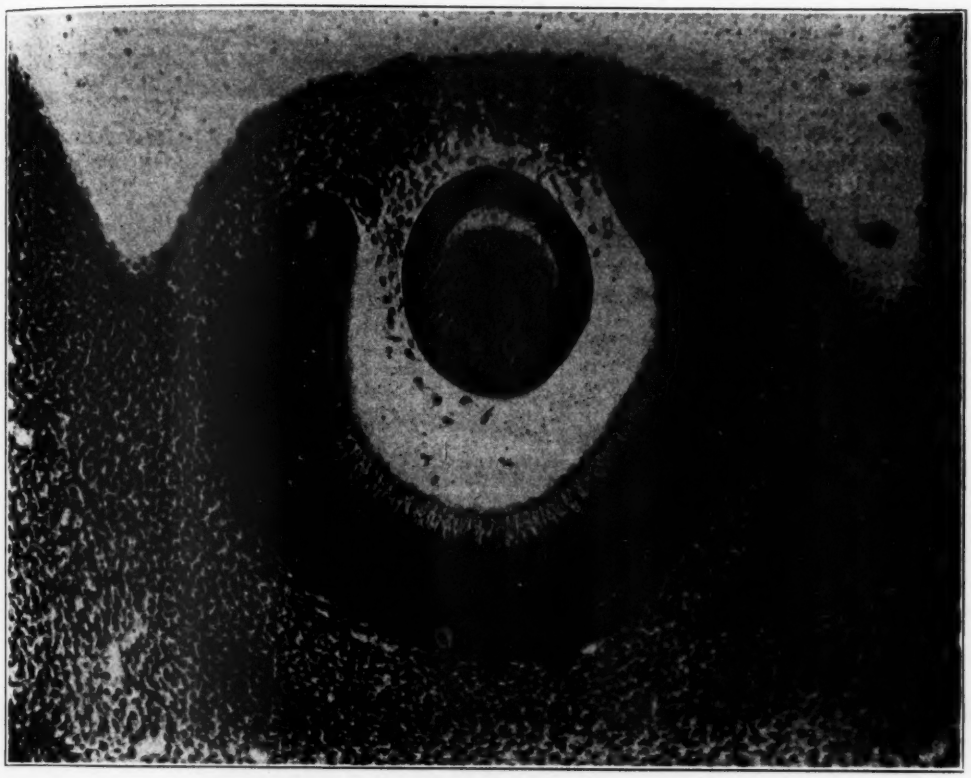

Fig. 1 (series 1197).—From a 10 mm. embryo; × 150.

Fig. 2 (series 4304).—From a 25 mm. embryo; × 30.

lary membrane. He was able to show that the mesoderm first grows into the space between the surface epithelium and the lens in such a manner as to form a single layer of cells which corresponded to Descemet's mesothelium. Later, there is an invasion of mesodermal cells from the periphery into the space between the ectodermal epithelium and the mesothelium, and here they proliferate, giving rise to the corneal stroma. The formation of the pupillary membrane is entirely independent of the corneal development. Seefelder, however, did not at this time have any

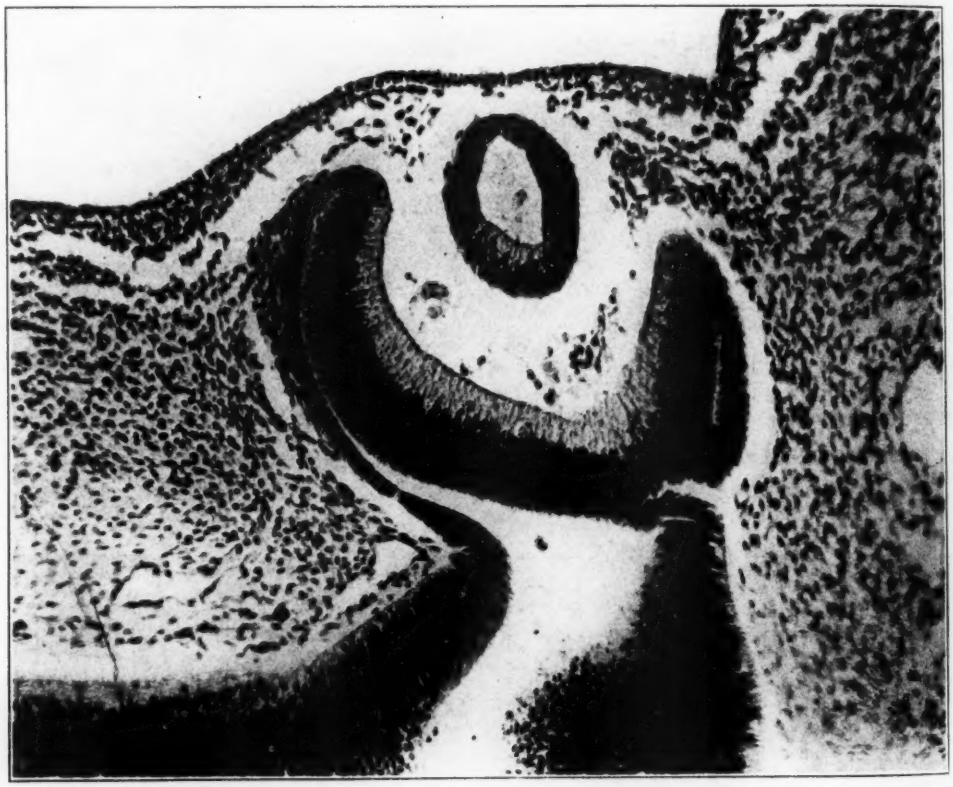

Fig. 3 (series 617).—From a 7 mm. embryo; × 150.

material illustrating the earliest stages of the growth of the mesothelium, and it was not until 1926 [4] that he could close this gap in the knowledge. Fischer [5] was able to confirm these findings, and recently Mann [6] has found enough evidence to convert her to this point of view.

I am presenting the following specimens from the collection of the Carnegie Embryological Institution of Washington, because they show

4. Seefelder: Arch. f. Augenh. **97**:156, 1926.
5. Fischer, Franz: Ztschr. f. Augenh. **64**:293, 1928.
6. Mann, Ida: Tr. Ophth. Soc. U. Kingdom **51**:63, 1931.

the entire early development of the cornea in such a manner as to leave no doubt as to the development.

In figure 3, the epithelium consists of one layer of cells with a slight depression over the lens.[7] The lens vesicle has completely separated from the surface epithelium. The mesoderm can be seen pushing in from the periphery and extending as a single layer beneath the surface epithelium, but not as yet reaching the center.

In figure 4, the mesoderm has grown across and arranged itself as a single layer of cells on the inner side of the surface epithelium. This is the earliest stage of the corneal primordium, and these two cell bands

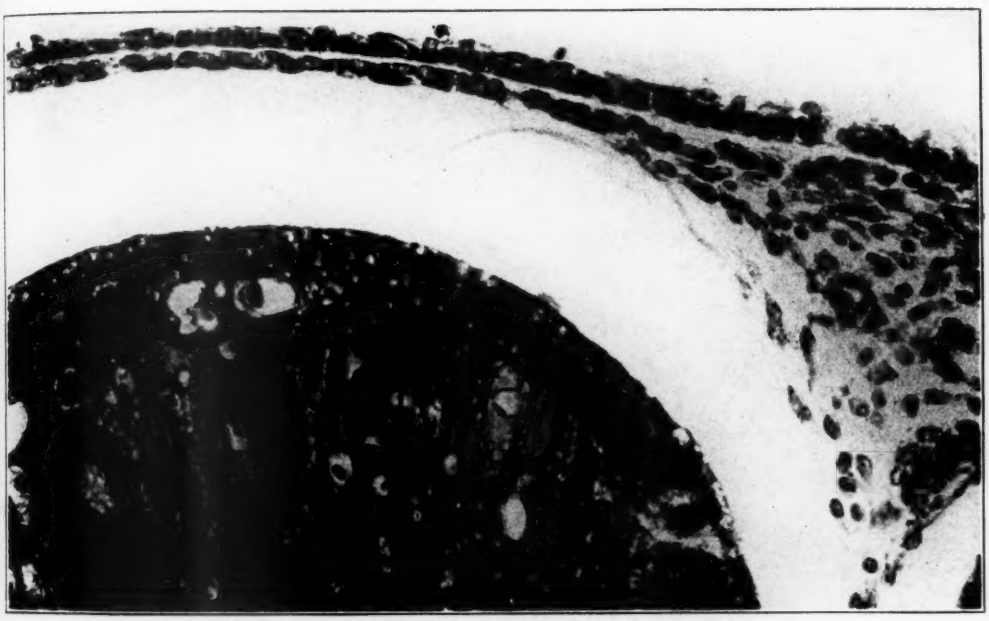

Fig. 4 (series 4148).—From a 21 mm. embryo; × 400.

represent the future epithelium and Descemet's mesothelium. Between these two layers there is a narrow space which extends across the entire extent and out into the periphery, and this is filled with fine fibrillae. The cells of the epithelium are in one stratum in the center, but toward the periphery they tend to become two-layered. The mesothelial cells are closely packed and slightly irregular in their arrangement, but will later become perfectly flat. There are no cells in the space between the two layers. The clump of mesodermal cells seen at the periphery on

7. It should be borne in mind that there is not an absolute relationship between the age of the embryo and the body length. It would be preferable to classify the age of the embryo in terms of the development of certain organs. From the specimens shown, it is obvious that some eyes are farther developed in the embryos of shorter body length.

the right is the primordium of the anterior sclera, and cells will grow out from this to form the corneal stroma. There is as yet no sign of a pupillary membrane.

In figure 5, the corneal primordium also consists of a two-layered epithelium and a one-layered mesothelium with a space between. The space is filled with a fibrillar substance, but shows a striking difference from the previous section. From the angle at the periphery there have penetrated into this space several mesodermal cells arranged one behind the other. These cells are slightly different from the mesodermal mass at the periphery in that they are elongated and have a rather pale nucleus. These represent the ingrowing fixed corneal cells, which will

Fig. 5 (series 4059).—From a 21.6 mm. embryo; × 400.

form the corneal stroma. In this specimen there can also be seen the beginning of the pupillary membrane, which is represented as an avascular band containing a few mesodermal cells and showing protoplasmic adhesions to the mesoderm at the periphery and to Descemet's mesothelium.

In figure 6, the space between the epithelial and mesothelial layers is increased in width. There has been an increase in the number of mesodermal cells in this space. This increase is the result both of the penetration from the peripheral mesodermal mass and of an actual proliferation of cells in situ, as can be proved by the mitotic figures seen. The amount of fibrillar substance between the mesodermal cells has also increased. The mesothelial cells have now arranged themselves in a smooth one-layered band. In the lower left hand corner the proto-

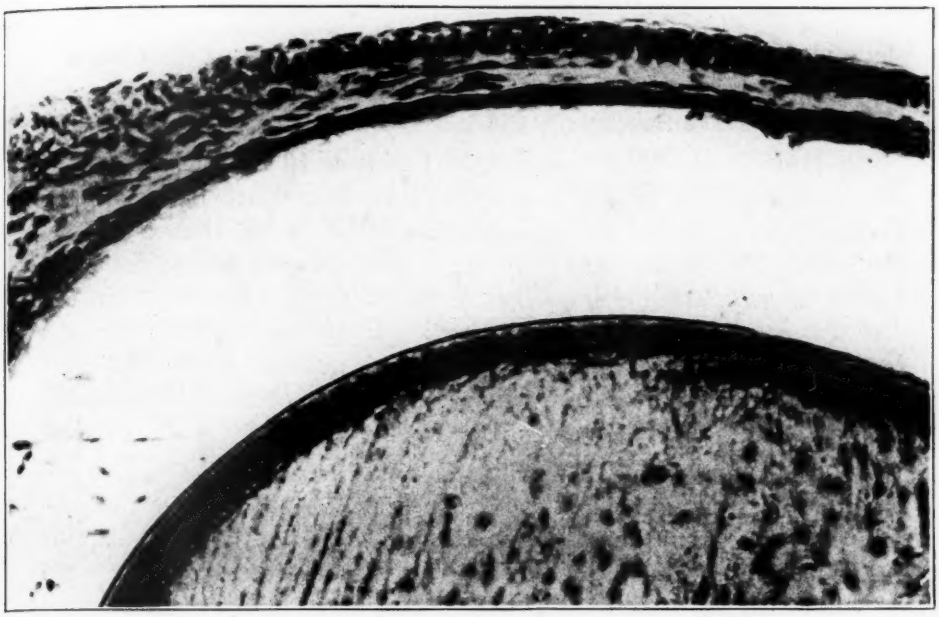

Fig. 6 (series 2937).—From a 24.2 mm. embryo; × 400.

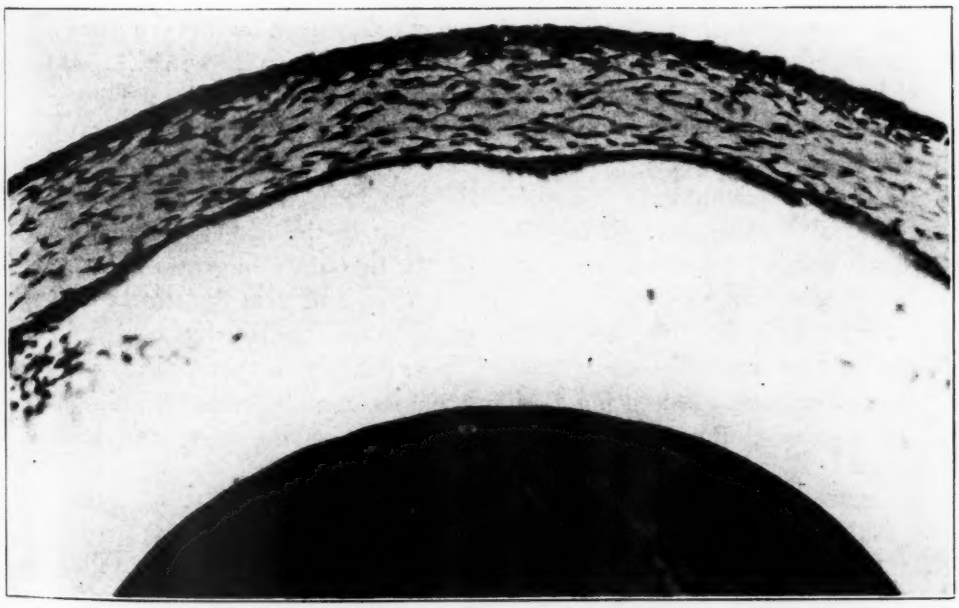

Fig. 7 (series 5725).—From a 23 mm. embryo; × 200.

plasmic band can be seen extending from the margins of the optic cup over to the anterior surface of the lens toward the vertex. This represents the pupillary membrane, and no vascularization is present as yet.

In figure 7, there has been a marked increase in the thickness of the cornea, owing to the proliferation of the mesodermal cells of the stroma. This proliferation has progressed to the same extent both anteriorly and posteriorly. These cells have not as yet arranged themselves in the regular lamellar form characteristic of the developed cornea. Between the cells can be seen numerous connective tissue fibrils, which the cells are producing. There are no signs of basilar membranes for either the epithelium or the mesothelium which would correspond with Bowman's or with Descemet's membrane.

In the earlier stages, following the detachment of the lens vesicle from the surface epithelium, numerous protoplasmic adhesions can be seen extending from the surface epithelium to the lens and the margins of the optic cup. The rôle of this anterior vitreous or mesostroma in the formation of the cornea has been a subject of considerable debate. Seefelder expressed the belief that the anterior vitreous is a transitory structure and plays no rôle in the development of the cornea. Knape [8] carried out extensive investigations in fowls and various other animals and felt that it played an essential part in the corneal growth, for he could show that the limiting layers were ectodermal structures, while the corneal stroma was a mixture of ectoderm and mesoderm. Von Szily [9] believed that as the mesoderm grew in beneath the surface epithelium, it became united with the fibers of the anterior vitreous so that it was difficult to distinguish the exact rôle played by this ectodermal structure. Laguesse [10] has confirmed Knape's findings in the chick. He showed that the mesostroma became divided into two layers by the mesodermal cells and that the anterior nucleus-free zone became Bowman's membrane, while the smaller posterior zone condensed to form Descemet's membrane. Recently, Hagedoorn [11] has studied a whole group of vertebrates, and he concluded that in the anterior vitreous a membrane is formed, posterior to which the mesothelium grows in as the first mesodermal element of the future cornea, and then the stroma cells grow in wedgelike into this membrane. Mann [6] confirmed Hagedoorn's findings on animals, and attempted to extend these researches to the human embryo. Admitting that her human material was insufficient, she concluded that the human embryo followed the same stages of

8. Knape: Anat. Anz. **34**:417, 1909.
9. von Szily: Anat. Hefte **35**:649, 1908.
10. Laguesse, E.: Arch. d'anat. micr. **22**:298, 1926.
11. Hagedoorn, A.: Brit. J. Ophth. **12**:479, 1928.

corneal development as in the chick, but that there was a great abbreviation of stages and a decrease in the amount of mesostromal tissue recognizable in man. She concluded that although the mesostroma is poorly developed in man, it is nevertheless the probable precursor of Bowman's and Descemet's membranes, which appear at a much later stage.

With the abundant material at my disposal, I have not been able to confirm this hypothesis of Mann's. Figures 4, 5 and 6 definitely show that the space between the epithelium and mesothelium is filled with a fibrillar substance. Whether this substance is the anterior vitreous, which persists according to Mann's conception or disappears rapidly as Seefelder believes, it is impossible to state. It can be seen in figure 6, however, that there is no actual ingrowth of the stroma cells as a layer which splits this fissure into an anterior and a posterior segment. The elongated mesodermal cells grow in from the periphery toward the center of the fissure, and, besides the invasion, there is an actual multiplication of cells so that they rapidly increase in number, as can be seen in figure 7. It would be difficult to believe that the mesostroma would remain invisible but sharply differentiated into two layers without developing into Bowman's and Descemet's membranes for several months. As can be seen in figure 7, there is no evidence of a zone of condensation beneath the surface epithelium or beneath the mesothelium. Descemet's membrane was first definitely recognizable by Seefelder at the 76 mm. stage and Bowman's membrane even later. As to their origin, it is impossible to state accurately, but from these findings on the human embryo, one could certainly feel that the mesostroma plays no rôle.

CONCLUSION

The cornea develops in man in a different manner from that in birds and some other vertebrates. Following the detachment of the lens vesicle, the mesoderm grows in as a single layer beneath the epithelium. There is then an invasion of mesoderm between these two cell membranes. Here the mesodermal cells proliferate and form the corneal stroma. The formation of the pupillary membrane is entirely independent of the development of the cornea. Bowman's and Descemet's membranes are not recognizable until a much later stage and certainly bear no relation to the mesostroma in the primitive cornea.

Clinical Notes

A SUTURE FORCEPS

R. O. Ebert, M.D., Oshkosh, Wis.

Corneal suture is done too infrequently because of its delicacy and the frequent complications, such as trauma and loss of vitreous.

Much of this danger can be eliminated by using the illustrated forceps. The suture needle easily passes through the torn or cut corneal margin between the two points of fixation of the forceps.

Suture forceps.

I have used the instrument especially in severe corneal lacerations and found that it functions even beyond my expectations.

Panas has invented an instrument of nearly identical construction, but about three times as large. His instrument was intended for general fixation about the eyeball, and is obviously too large for fine corneal suturing.

DELINEATION OF THE RETINAL PERIVASCULAR REGION IN A LIVING HUMAN EYE

John N. Evans, M.D., Brooklyn

In a recent communication,[1] the results of a series of investigations were reported on the delineation of the retinal perivascular region in animals. The object of that report was to review previous methods by which various workers had attempted to inject the so-called retinal perivascular lymph spaces and to submit the results of other experiments that I had devised.

The conclusions of the work tended to show that when the modified Weed-Wegefarth-Mott technic was used, prussian blue particles could be demonstrated about the retinal vessels. Study of the report mentioned will reveal that the test solution was injected into the anterior

Report made through the Research Department of the Brooklyn Eye and Ear Hospital.

1. Evans, J. N.: Retinal Perivascular Delineation, Arch. Ophth. **6**:823 (Dec.) 1931.

vitreous in a great number of experimental animals, dogs and rabbits, and that the results were consistently reproducible.

It is common knowledge that the finer anatomic features of eyes of these experimental animals differ radically from those of human eyes. Reference was made in the original communication to the efforts that had been made to reproduce the results in human eyes. Unfortunately, the material available had been so badly altered by disease as to make conclusions worthless. The prussian blue particles were not found in any significant relation.

It is thus obvious that it was necessary to secure a normal human eye on which to repeat the experiments performed on normal animal eyes if one wished to know whether parallel results could be found.

Dr. Conrad Berens, who had been working with me on a closely allied problem, was fortunate enough to secure the desired material. The following [2] is a summary of the circumstances under which the specimen herein presented was obtained:

"M. R., aged 27.

"Diagnosis: Sarcoma of the right antrum involving the right orbit. The eye was perfectly normal. There was a history of recurrent tumor of the right antrum since 1929. It persisted in spite of operations and radiation therapy. Vision in the right eye was 20/70 and had been failing slightly for the past two months. The patient complained of pain over the right eye. The right eyeball was displaced outward and upward by a solid mass extending into the orbit from the right antrum. The right iris was sluggish to direct light, but active to indirect light. The fundi of both eyes were apparently normal.

"Wegefarth's solution, 0.3 cc., was injected into the vitreous under slight pressure.[3] A tuberculin syringe and a 26 gauge needle were used and the fluid retained for one minute before the needle was withdrawn. The eye was enucleated twenty-four minutes later and immediately placed in 5 per cent acid formalin after having injected 0.2 cc. of 5 per cent acid formalin into the vitreous."

Microscopic Observations: No evidence of pathologic change could be found in any of the structures of the retina, choroid or vitreous. There was likewise no evidence of deviation from the normal in the structures of the anterior portion of the globe. (A description of the changes in the anterior segment referable to this experiment is reserved for a later report.)

The fine prussian blue particles could be seen clustered uniformly about the vessels as if laid down in some sort of space. At no place could granules be seen within the lumen. Not only the larger but also the most minute vessels were "coated" with the particles. This deposit of granules was also seen along fibers of the ganglion cells and enveloping the bodies of these larger cells. Occasional rows of granules could be seen about the fibers of the cells of the bipolar layer, and a coating of granules was also to be seen about the bodies of the bipolar cells. Every ganglion cell was not covered, nor was every bipolar cell covered, but areas appeared which showed this coating in both forms of cells.

The internal limiting membrane and the inner face of the fiber layer were heavily coated by granules in some regions, and the granules could be seen dipping deeply between certain masses of the nerve fibers.

At no place were prussian blue granules found within cells, and at no place was there staining by diffusion (evidence of solution) of the blue stain.

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2. The quotation is from a description Dr. Berens supplied.
3. See the previous study for details of the formulae and technic.

Photomicrograph of the normal human retina, showing the prussian blue particles deposited about the larger (*A*) and smaller (*B*) retinal vessels. *V* is the vitreous, in which prussian blue particles can be seen—some in focus and some out of focus. It is difficult to show these pale blue granules in photomicrographs, though this section was unstained. The binocular microscope is necessary in order to appreciate the location and distribution of the fine blue granules.

All in all, the findings were identical to those seen in the animal eyes in the original study.

A description of the distribution of the prussian blue particles within the nerve head and nerve proper is reported in a companion study made by Dr. Berens, which is to be presented at an early date.

In conclusion, it seems justifiable to state that in the human eye studied under the conditions of this experiment, prussian blue particles were found distributed in the retina immediately adjacent to the retinal vessels, nerve fibers, nerve fibrils, ganglion cells and bipolar cells and their processes.

This study would seem to be particularly significant, first because the evidence was derived from a living human eye; second because the precautions taken would make it appear that the findings are dependable, and third because of the probable relation which these studies have to the so-called retinal perivascular space and the posterior drainage system of the human eye.

Ophthalmologic Review
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DIETARY DEFICIENCY AND OCULAR DISEASE

I. S. TASSMAN, M.D.
PHILADELPHIA

THE VITAMINS

The many recent advances in the study of nutrition seem to have fairly well established the fact that certain of the vitamins are essential to an adequate diet for maintaining the growth and proper development of young animals. Numerous investigations have shown that the prolonged absence of certain vitamins from the diet of animals will lead to definite pathologic changes in some of the tissues. The exact way in which these changes are produced still remains unexplained, but clinically it is now accepted that certain diseases in man are associated, at least, with the absence of a particular vitamin from the diet; for example, scurvy is considered to be due to the absence of vitamin C, and for this reason vitamin C has come to be known as the antiscorbutic vitamin. Vitamin B is considered to exert a particular effect on the nervous system, and its presence in the diet will prevent beriberi. Vitamin G, which recently was differentiated from vitamin B, is now regarded as being particularly concerned in the production of pellagra. In the case of vitamin D, its influence in the prevention of rickets has been so generally accepted that it has been called the antirachitic vitamin. Today it is even considered necessary for the proper development of teeth in children. Mellanby, who has contributed greatly to the knowledge of both vitamin A and vitamin D, recently described the effects of diets of different calcifying properties on the incidence, spread and cure of dental caries in children, and he also showed how dental caries in children can be cleared up by the use of cod liver oil.

For a long time vitamin A has been designated as the "ophthalmic vitamin" because of its effect in preventing xerophthalmia. The results of some of the more recent investigations, however, seem to indicate that the withdrawal of vitamin A from the diet of animals causes earlier and more pronounced pathologic changes in other organs, with the result that the ocular changes have been receiving secondary consideration.

In 1927, Adler published a review of the subject of ocular disorders in deficiency diseases. In 1931, Laura Lane published a complete

review of the subject of the effect of foods with relation to ophthalmic conditions. Although vitamin A is still designated as the ophthalmic vitamin in addition to its other properties, some of the recent investigations are said to have demonstrated that vitamin G also has an effect on the normal state of the structures in and about the eyes, as well as affecting the growth of animals, particularly the rat.

EXPERIMENTAL VITAMIN A DEFICIENCY

Of the earlier investigators, Osborne and Mendel (1913) attempted to ascertain what constitutes an adequate diet by feeding experiments with isolated substances. They first found that their purely artificial food mixtures of isolated proteins, fats, carbohydrates and inorganic salts sooner or later failed to maintain mature animals. They thought, therefore, that such dietaries would naturally fail to maintain the less resistant young during their adolescent period. As a result of a number of maintenance experiments at first, they found that the great efficiency of milk in maintaing growth was dependent on the presence of butter fat rather than protein. A little later (1914) they found that rats grow normally on a diet containing cod liver oil, butter fat or egg yolk, whereas they fail to grow in the absence of these foods in the diet. These observations were confirmed at about the same time by McCollum and Davis, who also showed that there are certain foodstuffs which in animals are essential for normal growth over extended periods.

Again in 1921, Osborne and Mendel, experimenting with a deficient diet in rats, observed a group of symptoms, beginning with watering of the eyes, sometimes a slimy secretion between the eyelids, photophobia, redness and some swelling of the margins of the eyelids, which they called "ophthalmia," and which became evident before a decline in the body weight of the rats was observed. These symptoms were not found to be relieved by the use of antiseptics or local treatment, but disappeared within a week on the addition of 100 mg. of butter fat to the daily diet. They concluded that the primary etiologic factor in the ophthalmia of rats on deficient diets was a lack of vitamin A, and that this resulted in a hyalinization, or necrosis, of the outer layer of corneal epithelium with an exudation of serum and a proliferation of blood vessels and fibroblasts.

Based on the early works of McCollum and also on Osborne and Mendel's experiments on rats, Nelson and Lamb, in 1920, produced xerophthalmia in rabbits after feeding them a diet free from vitamin A for six days. Later, in 1921, Steenbock, Nelson and Hart produced an "ophthalmia," which they described as beginning with a conjunctivitis, in three dogs of a set of five, by feeding them a diet free from vitamin A for ninety-four days. They cured one of the dogs by the adminis-

tration of 20 cc. of cod liver oil daily, and another by giving 30 Gm. of saponified cod liver oil. The dog used as a control remained well.

In 1922, Shinosuki Mori published the results of a detailed investigation which showed that the changes taking place in animals fed a diet free from vitamin A occur primarily in the para-ocular glands. He found that in the lacrimal gland the most striking result was a shrinkage of the secretory cells of the acini, which no longer showed secretory zones. The nuclei became irregular and occupied the central part of the cytoplasm, which was small and stained poorly. The individual acini were small and could not be distinguished under the microscope. Even where the glands were not so severely affected, or where they appeared nearly normal, the cells showed no evidence of secretory activity. Sections of the lids of the animals with xerophthalmia often showed cystic dilatations of the ducts of the meibomian glands, the cysts being filled with fat. The epithelium of the margins of the lids showed a marked xerotic process, and the same change was found in the epithelium of the ducts. Mori stated that it is likely that this xerosis may play a part in occlusion of the ducts and the formation of retention cysts. The mucous cells of the conjunctiva were all entirely destroyed in the course of the xerotic process. Mori considered the changes in the lacrimal gland the most important in the pathologic picture, and to these changes he attributed the cause of the lesions found in the conjunctiva and cornea. He thus explained the dryness and the increased number of organisms found in the conjunctival sac.

The ocular manifestations resulting from the deficiency of vitamin A in the diet of rats were further investigated in detail by Yudkin. He found (1922), in feeding six rats a diet of casein, mineral salts, starch, lard and yeast, that the first ocular changes appeared in about forty-five days and that they consisted of a watery lacrimation and a somewhat viscid conjunctival secretion. The rats seemed to dread the light and showed signs of irritation, rubbing the eyes with the front paws. This was followed by an accumulation of crusts on the lids. He killed the rats in the early stages of the condition, and the eyes with the lids attached were embedded and sectioned. Yudkin stated that in all cases he found early focal infections in the epithelial lining of the eyelids. The changes consisted of localized foci of degeneration of the epidermis with cellular infiltration, which in some cases extended into the subepidermal tissue. In all of these early cases the cornea was found uninvolved, showing no degenerative changes that could be recognized by ordinary stains and no cellular or vascular reactions. These findings suggested that the corneal changes have their origin in the lids, the sequence of events being the same as that occurring in the more severe types of acute and chronic conjunctivitis complicated by

corneal involvement. In the lacrimal gland he found a marked pathologic change, either degenerative or inflammatory in nature.

In a later article on the changes in the para-ocular glands, Lambert and Yudkin stated, like Mori, that in rats the changes are primarily outside of the eye, namely, in the lacrimal gland or the harderian and meibomian glands. They disagreed with Mori in that a drying of the eye with a cornification of the epithelium precedes the conjunctival reaction of the lids. They thought that the conjunctival reaction was essentially that of a bacterial infection; that, contrary to Mori's findings, lacrimation was a striking feature in the early stage of the condition, and that some of the later changes with drying of the cornea might be due to a deficient lacrimal secretion.

The subject was somewhat further confused at this time by the findings of McCollum, Simmonds and Becker (1922), who reported that they produced a condition in rats resembling xerophthalmia by using a diet with a high sodium content, and they suggested that etiologic factors were involved, causing "ophthalmia" or an ocular condition which might easily be confused with xerophthalmia due to a lack of vitamin A.

While these investigations were being carried on, von Szily and Eckstein reported the production of cataract in young suckling rats as a form of avitaminosis, the result of feeding the mother rats a diet free from vitamin A. Jess carried out a similar investigation, but failed to confirm these results.

The specific tissue changes in the conjunctiva, meibomian gland ducts, lacrimal glands, harderian glands and cornea were fully investigated and reported by Wolbach and Howe in 1925. Their results, which are generally accepted today, showed that in animals deprived of fat-soluble vitamin A there occurs a replacement of the columnar epithelium by a stratified, squamous, keratinizing type. A little later this fact was supported by the findings of Goldblatt and Benischek, who claimed that a diet deficient in vitamin A alone would produce in certain organs a metaplasia of columnar, cuboidal and transitional epithelium of the squamous, keratinizing form.

At about the same time Mellanby conducted some experiments which led him to advance the theory of the anti-infective property of vitamin A. In 1925, during the course of his experiments, he found quite by accident that his young animals which were deprived of vitamin A in the diet died of bronchopneumonia, and that when cod liver oil or butter fat was fed, this did not occur. In association with Green (1928), he later found that young rats fed a diet free from vitamin A but rich in all other factors died as the result of an infection. They also found that the infection could be prevented or cured by the

addition of vitamin A to the diet of these animals. The same authors recently called attention (1929) to the fact that this action of vitamin A is the same as that of carotene, which has been considered by some to be closely related to vitamin A. The young rats that were deprived of vitamin A were fed carotene, with the same results as that obtained by feeding vitamin A. The investigations of von Euler, von Euler and Hellström had previously demonstrated a similarity in the effect of these substances on the growth of young animals.

Moore, in speaking of vitamin A and carotene, stated that carotene, or some part thereof, if it should later be proved to be heterogeneous, behaves in vivo as a precursor of the vitamin.

Green and Mellanby were so impressed with the anti-infective property of vitamin A that they attempted to test its effect in cases of puerperal infection, and although the investigation is not completed, the results reported thus far seem to indicate that vitamin A has some action in at least raising the resistance in patients suffering from this infection (1930).

With this in mind, Lassen recently published the results of an investigation in which young rats which were on a diet free from vitamin A, followed by pronounced xerophthalmic symptoms, were inoculated by mouth and by subcutaneous injection with paratyphoid. The course of the infection and the bacteriologic autopsy showed a marked decrease in the resistance of these animals to this infection as compared with rats which were on an adequate diet. The experiments did not show any change in the mechanism of infection in pronounced vitamin A deficiency.

Burton and Balmain, however, after administering vitamin A, concluded that their results suggested no prophylactic value in preventing puerperal fever. They suggested that the prophylactic effects sometimes observed were largely a coincidence, and that even though a deficiency of vitamin A has been shown to predispose to changes in epithelial linings and, therefore, to enhance infection, it did not, in their opinion, justify the belief that the occurrence of infection could be prevented by an adequate supply of this vitamin, in the presence of a sufficient infective agent and an absence of immunity.

Although the lesions described by Green and Mellanby occurred mostly in the tongue, respiratory tract, nasal sinuses, gastro-intestinal tract and middle ear, the eye and its appendages were not specifically mentioned. In this respect the recent investigations of Tilden and Miller, who used a diet deficient in vitamin A in monkeys, showed not only an absence of ocular signs, but an absence of lesions of the sinus, middle ear and tongue as well. Nearly all of their monkeys died of gastro-intestinal infections, but it was explained that the animals might

under certain conditions also show pathologic changes in other organs. It is possible that the respiratory or alimentary tract is much more susceptible and the lesions here progress more rapidly, leading to death of the animal before lesions elsewhere become manifest. Even more recently, Wolfe and Salter found changes in the respiratory tract of the mouse much more extensive than the ocular changes, which, however, were present to a degree.

In a series of young rats in which I attempted to maintain a diet deficient in vitamin A sufficient to produce the early ocular signs, two of the animals died before any ocular symptoms, other than a watery secretion of the eyes, developed. The rats, however, had shown a marked decrease in weight and died at the end of ten weeks. In the other rats, the early ocular signs of the deficiency occurred at about the same time. These symptoms improved on the addition of cod liver oil to the diet, but the rats did not survive long enough to note the results of repeated withdrawals. As I was interested at the time in observing only the ocular manifestations, no autopsies were performed on the rats. From the results of other more detailed investigations, however, it is possible that the rats suffered from severe gastro-intestinal disturbances and also pneumonia, which resulted in death.

McCollum and Simmonds (1925) stated that it is significant that a deficient diet produces a complicated pathology, and that it is doubtful whether a deficiency disease occurs uncomplicated in man or animal.

The lack of vitamin A in the diet of pigs, chickens and cows was studied by Hughes, Lienhardt and Aubel, who reported marked nervous symptoms characterized by impaired vision, incoordination and spasms. Histologic examination of the nerves of pigs in the advanced stage of avitaminosis showed a degeneration of some of the nerve bundles, among which they included the optic nerve.

CLINICAL MANIFESTATIONS

Although the reports of laboratory experiments have been rather plentiful, comparatively few clinical cases of classic vitamin A deficiency have been reported in this country. This is, of course, explained by the fact that a real deficiency of vitamin A in the diet does not occur to the same extent that it does in countries of the East. It will be recalled how Bloch, in 1917, described xerophthalmia occurring in the children of Denmark during the early days of the World War because of the lack of butter among the civilian population. This condition cleared up as soon as butter was again rationed out among the people of that country.

In 1928, Langdon, in this country, described in detail a case of corneal dystrophy in a young woman who never used butter, eggs or

milk. The condition was cleared up by the use of cod liver oil and by correction of the diet.

Perhaps the most detailed clinical description of the results of vitamin A deficiency on the eye was published by Arnold Pillat in 1929. Pillat had an opportunity to study a great many of these cases among the soldiers of Northern China, and he described the effects on the eye as a distinct disease, the manifestations of which he grouped into separate stages. Brief mention of some of the more prominent manifestations described might be of interest and perhaps of some importance here. First, night blindness, which occurs as one of the early symptoms and is not accompanied by ophthalmoscopic findings, may occur alone or in association with other ocular symptoms. A mild degree of night blindness might not be recognized by the patient who comes to the physician with various other complaints or symptoms of the deficiency. The second stage is xerosis epithelialis conjunctiva, which he describes as a dryness of the conjunctiva of the eyeball, and which appears in four clinical forms: Bitot's spots, irregular xerosis of the bulbar conjunctiva, loss of luster of the bulbar conjunctiva and wrinkling of the bulbar conjunctiva. Bitot's spots are triangular white spots resembling the dense foam of soap in the region of the palpebral fissure, with the base at the limbus and the apex directed toward the angle. The next stage of the condition is xerosis of the corneal epithelium, which is often associated with xerosis of the conjunctiva, but it can occur alone in rare cases. The final stage of the condition is keratomalacia, which until recently was described as occurring only in infants, but is now said by Pillat to occur in all forms in adults in China. In addition to these definite signs of the condition, other symptoms and signs of vitamin A deficiency are frequently met with, but it is said that they will require further study since the lack of vitamins C and D may also play a part. These signs include pigmentation of the cornea, which is a light brown color and is most marked in the semilunar fold and caruncle, extending from there first into the fornices and then to the bulbar and lid conjunctiva. Histologically, the pigment is found chiefly in the basal cell layer of the epithelium. This pigmentation occurs in the mildest and severest cases of vitamin A deficiency and is often the last symptom to disappear. It may be associated with night blindness or it may occur alone.

Meibomitis is also of frequent occurrence. In the opinion of Pillat, the disease is not primarily of inflammatory origin, but is caused by inactivity of the meibomian glands. This inactivity causes the fatty content of the glands to be kept in the excretion ducts, irritating the gland itself and the margin of the lids, which allows germs to enter the glands and gives rise to a secondary inflammation.

Blepharitis and hordeolum are common in cases of vitamin A deficiency, being caused by the prevalence of bacteria in all parts of the eye and by the decrease of lacrimal fluid, which occurs mostly in advanced cases of longstanding. Pillat finally mentions comedones in the neighborhood of the eyes. All of these accessory symptoms disappear with the ocular symptoms by proper nourishment or by proper treatment with cod liver oil.

Night blindness was found by Luis Gamboa to occur among the natives of the Philippine Islands owing to the lack of vitamin A. The condition was cured by the addition of fats and cod liver oil to the diet.

Night blindness, which is perhaps better considered as a symptom, has of late been receiving considerable attention, especially in connection with investigations made on the retina. In 1925, Fridericia and Holm showed that the visual purple of the retina, after exposure to strong sunlight, was slow to regenerate in rats which had been on a diet free from vitamin A. It was also shown by Holm that vitamin A is plentiful in the retina. This finding was later supported by Yudkin, Kriss and Smith, who also showed that the retina was rich in vitamin A. They alleviated the characteristic symptoms of vitamin A deficiency in rats by feeding them 50 mg. of dried normal retina daily. In a subsequent article recently published by Yudkin (1931), he showed that the retina of the hog is richer in vitamin A than is butter fat. The choroidal tissue, on the other hand, he found almost devoid of that substance. The results of these experiments seem to indicate a close relationship between the normal function of the retina and the presence of vitamin A. As clinical evidence, Yudkin referred to the cases observed by Aykroyd among the fishermen of Labrador, who suffered with night blindness after being exposed to the strong sunlight at sea. Night blindness appears to be a rather frequent occurrence among these people, who were on a deficient diet, but it is cleared up by the use of cod liver oil. According to Aykroyd, some of the more experienced fisherman, while out at sea, keep one eye covered to insure its usefulness when they returned.

An attempt was made recently by Kendall and Gifford to show a connection between trachoma and avitaminosis in white rats. They instilled into the eyes of white rats that had been thoroughly deprived of vitamin A some fresh trachoma material from which Bacterium granulosis was isolated, but their results were negative. They explained, however, that white rats may have a degree of resistance to the trachoma virus greater than the effect of a prolonged starvation of vitamin A, and also that the etiologic relationship of Bacterium granulosis is not yet agreed on. Therefore, it cannot be dogmatically asserted that these experiments are conclusive.

This work was similar to that performed by Tilden and Miller on monkeys. These investigators inoculated monkeys that were on a diet deficient in vitamin A with Bacillus granulosis (Noguchi), but the characteristic lesions failed to develop in the animals. It was explained that the period of incubation in monkeys so inoculated varies from two weeks to three months, and all but one of the monkeys on the deficient ration died before the lapse of the maximum incubation period. They thought, in addition, that the infecting material used may have been taken too late in the course of the disease, and for that reason contained too few organisms to produce infection, especially when distributed among monkeys. No conclusions could be drawn from these experiments.

Pronounced clinical manifestations which compare with the results of investigations on laboratory animals are rarely seen by the ophthalmologist because the diet of a person is probably never restricted to the same extent and with the same exactness as to produce the results obtained with the experimental animals. On the other hand, it is a fact that many people are found who subsist for long periods on a diet which is uniform and at the same time deficient to a certain extent in the factors essential to a well balanced diet. Although economic conditions and habitat are often the chief factors which determine the nature of a diet, habit, custom and personal taste will frequently cause a person to follow a uniform and unchanging diet for years, without any consideration of its nutritive value. Should such a diet be found deficient in the vitamin considered essential, it could reasonably explain the clinical presence of certain ocular manifestations, which, although apparently not of a serious nature at first, become recurrent and progressive with the lapse of time. Such patients may be suffering from a partial deficiency, which in the particular case might produce the early signs and symptoms corresponding to those described by some of the earlier investigators in laboratory animals. In patients on a restricted diet over a long period for the treatment of some general disease, the danger of producing symptoms of a deficiency disease is of course obvious.

Davis reported a case of xerophthalmia in a patient 65 years of age, which was completely cleared up by means of simple local applications and regulation of the diet. After the patient had been on the diet for ten days, she was once more able to see, having been unable to do so for a period of time.

Among children, marginal blepharitis, chronic conjunctivitis, phlyctenular conjunctivitis or keratoconjunctivitis, recurring chalazion and hordeolum and, in those a little older, episcleritis and some cases of simple ulcer of the cornea should indicate the need for a careful inquiry into the nature of the diet. In children who from birth have

never received a sufficient quantity of vitamins for their needs of development, the opportunity has not been afforded for a storage of vitamin A in the tissues. When it is remembered that the importance of this subject has been emphasized only during the past few years, it is easy to understand why those children now 10 years of age or older did not in infancy receive the benefit of the knowledge concerning these essentials that is known today. As a result, they are more prone or susceptible to the conditions now recognized as resulting from dietary deficiencies. This seems to be well demonstrated experimentally by the work of Sherman and Burtis, in which they fed one set of rats up to the age of 4 weeks a diet poor in milk, while another set was fed the same diet somewhat richer in milk. After this the rats were all placed on a diet free from vitamin A for about one month, until in each the surplus store of vitamin A in the body was exhausted. For the next eight weeks they again received the same limited allowance of food containing vitamin A. At the end of this test period, autopsies showed that infections had occurred in 75 per cent of those which in early life received the diet poor in milk, against 25 per cent in those which during the same period received the diet with a larger proportion of milk. Sherman and Burtis explained that, taking account of the relative lengths of the life cycle in the rat and in man and of the similarity of nutrition in the two species, their results would be an indication of the differences of incidence of infection to be expected among children around 10 or 12 years of age resulting from the differences in the way they were fed before the age of 3.

DEFICIENCY OF VITAMIN G

In 1926, Goldberger and his associates showed that vitamin B is made up of two fractions. The one which is at times still called B or B_1 is the antineuritic factor, while the second, sometimes called B_2 and by others G, is the one concerned in pellagra. Since that time the B complex has been the subject of animal experimentation, with the production of ocular lesions. Only recently, Day, Langston and O'Brien described the production of cataracts in young albino rats which received a diet deficient in vitamin G between sixty and eighty-seven days. In other animals receiving a diet deficient in vitamin A, this condition did not occur. This work was said to be based on the earlier investigations of Goldberger and Lillie, Chick and Roscoe, Thatcher and Sure, Walker and others. All of these investigators found that on depriving rats of vitamin G, a variety of ocular symptoms was produced after a time. The symptoms included lacrimation, conjunctivitis with a pasty condition of the eyelids and, in nearly all, an alopecia of the eyelids. In some cases the cornea was affected by opacities, while in others there

were opacities in the vitreous, but only in one was opacity of the lens noticed. In the report of Day, Langston and O'Brien, all of the ocular manifestations were also noted, but they found that these changes cleared up when the rats were fed autoclaved yeast, which is rich in vitamin G. Further progress of the changes was said to have been checked.

Sherman and Sandels, in their experiments, found that in rats deprived of vitamin G loss of hair occurred about the eyelids and cutaneous lesions developed around the eyes. In one case they described a keratitis, while in another a section of the lacrimal glands showed an inflammatory process. They thought that the ocular lesions occurred in cases in which the deprivation was at once very great, rather than in those in which the rats were partially deprived for a longer time.

In 1929, Shastid reported two cases of optic neuritis of unknown origin in patients to whom he administered yeast. In both cases the condition cleared up, and in one case no other treatment of any kind was used. Shastid suggested the connection of vitamin B deficiency with the cause of optic neuritis in these patients.

SUPPLEMENTAL DIETARY TREATMENT

In all cases in which a vitamin deficiency in the diet is strongly suspected, it may not be possible to correct the diet satisfactorily by the addition of the necessary foods, but vitamin A can always be supplied in the form of cod liver oil. In May, 1930, Stiles reported the use of a preparation in which he combined cod liver oil, in proportions of 1 : 10 and 1 : 20, with a brown mercurial ointment described by Casey Woods as ointment of mercuric nitrate. He described the local application of the preparation to patients suffering from various diseases of the cornea and especially to some debilitated patients with opacities. It was also said to be beneficial in the treatment of blepharoconjunctivitis and some altered conditions of the eyelids due to chronic inflammations in older people. I attempted to use this preparation in certain cases, but found it to be too liquid when used as described, and therefore I had it prepared with enough hydrous wool fat to render it more firm and more applicable. The additional use of cod liver oil by mouth and correction of the diet would seem a far more important part of the treatment in recurrent cases than the astringent washes, applications of yellow mercuric oxide and other local medication ordinarily prescribed.

Cod liver oil has been demonstrated by Jones, Steenbock and Hart to contain from ten to twenty times as much vitamin A as butter fat. Although this offers an easy and immediate method for supplying vita-

min A to a patient, the proper correction of the diet should not be omitted. The commoner foods known to be rich in vitamin A include:

1. Fats and oils: butter, cream, cod liver oil, mutton and beef fat, peanut oil and nut butters.
2. Meats: liver, kidney, heart, brain and sweetbreads.
3. Fish: salmon, herring and roes.
4. Milk: cow's whole milk, raw; dried whole milk; sweetened condensed milk, and whole milk cheese.
5. Eggs: fresh or dried.
6. Vegetables: fresh cabbage, lettuce, dried spinach and fresh raw carrots.
7. Bananas and nuts.

The method of absorption and disposition of the vitamin is a subject concerning which little is known. Although vitamin A is present in the feces, its exact fate after ingestion is still a matter of investigation.

A study of the absorption and retention of vitamin A in young children by Rowntree showed that vitamin A is not excreted through the urine of young children and infants even when generous amounts are fed. If there is a limit to the capacity to store vitamin A, it is not indicated by alimentary vitaminuria. Without exception, a marked fecal loss was found to occur, but it was felt that this loss was not entirely dependent on the intake, as shown by the fact that two infants fed a diet low in vitamin A excreted a larger amount than they ingested. The loss with different children on different diets varied from 2 to 12 per cent of the intake, the largest loss occurring with the largest intake. The greatest retention also occurred on the greatest intake. Since the excretion of fecal fat of infants is normally within this range, it seems that the loss of vitamin runs parallel with the loss of fat. The vitamin A of egg yolk and cod liver oil appears equally well utilized.

CONCLUSION

After this article was written, there began to appear in *The Journal of the American Medical Association* a series of special articles on the present status of the knowledge of vitamins, prepared under the auspices of a committee composed of Morris Fishbein, chairman, Lafayette B. Mendel and Julius Hess, representing a joint committee of the Council on Pharmacy and the Committee on Foods (Mendel; Eusterman and Wilbur; Kruse and McCollum). These excellent articles by highly recognized authorities in this field present in the best form obtainable the knowledge derived from the important scientific investigations thus far recorded. In summing up the results of vitamin A deficiency, it appears that the changes in the eyes and para-ocular glands are only part of a complication of changes affecting various epithelial structures. Whether or not the anti-infective property of vitamin A is eventually

satisfactorily proved and accepted, it seems at present that it is at least considered important in maintaining normally healthy epithelial tissue, thereby setting up a barrier to resist infection.

In a recent editorial on the early stages of vitamin A deficiency appearing in *The Journal of the American Medical Association,* it was stated in part that, "Among the difficulties encountered is the circumstance that the incipient stages of avitaminosis are not at all well defined." Reference is made to McLester, who

> asserted that the interest which vitamins hold for the physician is not alone in their relation to certain well defined diseases such as scurvy, beriberi and rickets but rather in the fact that chronic vitamin deficiency produces numerous vague, borderline states of ill health which often puzzle the physician and disable the patient. These last are of far greater importance to the physician of today than the more clearly defined deficiency diseases.

In referring to the studies by Thatcher and Sure at the University of Arkansas, it is said:

> They have become interested in the early stages and incipient signs of vitamin A deficiency. Their animal experiments lead them to conclude that pathologic changes may take place in the tissues before any definite signs of external symptoms are apparent. For example, metaplastic changes in the posterior part of the tongue, in the salivary glands, and in the respiratory and urinary tracts were found during early stages of vitamin A deficiency in a large proportion of animals that made normal growth, some of which showed incipient ophthalmia or persistence of the cornified stage of estrus as the only sign of vitamin A deficiency, and others of which showed no external signs of A avitaminosis.

In line with the hypothesis that the common cold and bronchitis or bronchopneumonia associated with A avitaminosis follow metaplasia of the epithelial structures in the respiratory tract in man, as suggested by Thatcher and Sure, it would seem that the same reasoning would apply to certain conditions often affecting the eyes, also as the result of vitamin A deficiency causing an earlier metaplasia of the epithelial structures.

BIBLIOGRAPHY

Adler, F. H.: Ocular Disorders in Deficiency Diseases, Arch. Ophth. **56**:593 (Nov.) 1927.

Aykroyd, W. R.: Beriberi and Other Food-Deficiency Diseases in Newfoundland and Labrador, J. Hyg. **30**:357 (Aug.) 1930.

Bloch, C. E.: Blindness and Other Diseases in Children Arising from Deficient Nutrition (Lack of Fat-Soluble A Factor), Am. J. Dis. Child. **27**:139 (Feb.) 1924.

Burton, A. H. G., and Balmain, A. R.: Vitamin A and Streptococcal Antitoxic Immunity, Lancet **1**:1063 (May 17) 1930.

Davis, W. T.: Xerophthalmia: Report of a Case, J. A. M. A. **98**:1640 (May 7) 1932.

Day, P. L.; Langston, W. C., and O'Brien, C. S.: Cataract and Other Ocular Changes in Vitamin G Deficiency, Am. J. Ophth. **14**:1005 (Oct.) 1931.

Editorial: Early Stages of Vitamin A Deficiency, J. A. M. A. **98**:2290 (June 25) 1932.

von Euler, B.; von Euler, H., and Hellström, H.: A-Vitaminwirkungen der Lipochrome, Biochem. Ztschr. **203**:370, 1928.

Eusterman, G. B., and Wilbur, D. L.: Clinical Features of Vitamin A Deficiency, J. A. M. A. **98**:2054 (June 11) 1932.

Fridericia, L. S., and Holm, E.: Experimental Contribution to the Study of the Relation Between Night Blindness and Malnutrition, Am. J. Physiol. **73**:63, 1925.

Gamboa, Luis: Deficiency in Vitamin A and Nyctalopia, J. Philippine Islands M. A. **10**:235 (June) 1930.

Goldberger, Wheeler, Lillie and Rogers: A Further Study of Butter, Fresh Beef, and Yeast as Pellagra Preventives, Pub. Health Rep. **41**:297, 1926.

Goldblatt, H., and Benischek, M.: Vitamin A Deficiency and Metaplasia, J. Exper. Med. **46**:699 (Nov.) 1927.

Green, H. N., and Mellanby, T. E.: Vitamin A as an Anti-Infective Agent, Brit. M. J. **2**:691 (Oct. 20) 1928; **1**:984 (June 1) 1929.

Carotene and Vitamin A, Brit. J. Exper. Path. **11**:81 (April) 1930.

Holm, E.: Demonstration of Vitamin A in Retinal Tissue, Acta ophth. **7**:146, 1929.

Hughes, J. S.; Lienhardt, H. F., and Aubel, C. E.: Nerve Degeneration Resulting from Avitaminosis A, J. Nutrition **2**:183 (Nov.) 1929.

Jess, A.: Klin. Monatsbl. f. Augenh. **74**:49, 1925.

Jones, J. H.; Steenbock, H., and Hart, E. B.: Fat-Soluble Vitamins, J. Biol. Chem. **61**:775 (Oct.) 1924.

Kendall, A. I., and Gifford, S. R.: Trachoma and Avitaminosis, Arch. Ophth. **4**:322 (Sept.) 1930.

Kruse, H. D., and McCollum, E. V.: Review of Recent Studies on the Antineuritic Vitamin, J. A. M. A. **98**:2201 (June 18) 1932.

Lambert, R. A., and Yudkin, A. M.: Changes in the Paraocular Glands Accompanying the Ocular Lesions Which Result from a Deficiency of Vitamine A, J. Exper. Med. **38**:25 (July) 1923.

Lane, L. A.: Practical Points in Ophthalmic Practice: A Study of Recent Food Researches, J. A. M. A. **98**:726 (Feb. 27) 1932.

Langdon, H. M.: A Case of Dystrophy of the Cornea Which Disappeared on the Administration of Fats, Am. J. Ophth. **11**:386 (May) 1928.

Lassen, H. C. A.: Vitamin A Deficiency and Resistance Against a Specific Infection, J. Hyg. **30**:300 (Aug.) 1930.

McCollum, E. V., and Davis, M.: The Necessity of Certain Lipins in the Diet During Growth, J. Biol. Chem. **15**:167, 1913.

——and Simmonds, N.: Newer Knowledge of Nutrition, New York, The Macmillan Company, 1925.

——Simmonds, N., and Becker, J. E.: Type of Ophthalmia Caused by Unsatisfactory Relations in the Inorganic Portion of the Diet, J. Biol. Chem. **53**:313 (Aug.) 1922.

Mellanby, E.: Diseases Produced and Prevented by Certain Food Constituents, J. A. M. A. **96**:325 (Jan. 31) 1931.

Mendel, L. B.: Vitamin A, J. A. M. A. **98**:1981 (June 4) 1932.

Moore, T.: Vitamin A and Carotene, Biochem. J. **24**:692, 1930.

Mori, Shinosuki: The Changes in the Para-Ocular Glands Which Follow the Administration of Diets Low in Fat-Soluble Vitamin A, Bull. Johns Hopkins Hosp. **33**:357 (Oct.) 1922.

Nelson, V. E., and Lamb, A. R.: The Effect of Vitamin Deficiency on Various Species of Animals: The Production of Xerophthalmia, in the Rabbit, Am. J. Physiol. **51**:530, 1920.

Osborne, T. B., and Mendel, L. B.: Relation of Growth to Diet, J. Biol. Chem. **16**:423, 1913.

Influence of Cod-Liver Oil and Other Fats on Growth, J. Biol. Chem. **17**:401, 1914.

Ophthalmia and Diet, J. A. M. A. **76**:905 (April 2) 1921.

Pillat, Arnold: The Main Symptoms of the Eye in Vitamin A Deficiency in Adults, Nat. M. J., China **15**:585 and 614, 1929.

Rowntree, J. I.: Absorption and Retention of Vitamin A in Young Children, J. Nutrition **3**:265 (Nov.) 1930.

Shastid, T. H.: Optic Neuritis and Vitamin B, Am. J. Ophth. **12**:903 (Nov.) 1928.

Sherman, H. C., and Burtis, M. P.: Vitamin A in Relation to Growth and to Subsquent Susceptibility to Infection, Proc. Soc. Exper. Biol. & Med. **25**:649, 1928.

——and Sandels, M. R.: Further Experimental Differentiation of Vitamins B and G, J. Nutrition **3**:395 (Jan.) 1931.

Steenbock, H.; Nelson, E. M., and Hart, E. B.: Fat Solüble Vitamins: The Incidence of an Ophthalmic Reaction in Dogs Fed a Fat Soluble Vitamine Deficient Diet, Am. J. Physiol. **58**:14, 1921.

Stiles, C. M.: Cod-Liver Oil in the Treatment of Corneal Opacities, Am. J. Ophth. **13**:423 (May) 1930.

von Szily, A., and Eckstein, A.: Vitaminmangel und Schichtstargenese, Klin. Monatsbl. f. Augenh. **71**:545, 1923.

Tilden, E. B., and Miller, E. G., Jr.: Response of Monkey (Macacus Rhesus) to the Withdrawal of Vitamin A from the Diet, J. Nutrition **3**:121 (Sept.) 1930.

Wolbach, S. B., and Howe, P. R.: Tissue Changes Following Deprivation of Fat Soluble Vitamin A, J. Exper. Med. **42**:753 (Dec.) 1925.

Wolfe, J. M., and Salter, H. P., Jr.: Vitamin A Deficiency in the Albino Mouse, J. Nutrition **4**:185 (July) 1931.

Yudkin, A. M.: Ocular Manifestations of the Rat Which Result from Deficiency of Vitamin A in the Diet, J. A. M. A. **79**:2206 (Dec. 30) 1922.

Experimental Xerophthalmia in Rats, Proc. Soc. Exper. Biol. & Med. **19**:375, 1922.

The Presence of Vitamin A in the Retina, Arch. Ophth. **6**:754 (Oct.) 1931.

——Kriss, M., and Smith, A. H.: Vitamin A Potency of Retinal Tissue, Am. J. Physiol. **97**:611 (July) 1931.

Miscellany

STATISTICS OF CATARACT EXTRACTION

EXTRACTS FROM THE OFFICIAL RECORDS OF THE INDIA OFFICE

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The statistics for the Central Provinces and the Foreign Department (native states), which together form more than one third of India, were not available, nor were those for the Northwest Frontier Province since 1913. Before that date this province was included in the Punjab; hence the figures for the latter should be somewhat larger than they are in the table since that date for purposes of comparison with earlier years. The figures of the work done by the mission hospitals are not included; that is, those for the Bombay Presidency take no account of the 1,500 patients operated on annually by Dr. H. T. Holland, of the Church Mission Society Mission, at Shikarpur in Sind during the months of January and February.

Analysis of these figures shows that in the years around 1895 about 5,000 cataracts were extracted annually in the Punjab, mainly by capsulotomy, for intracapsular extraction was then in its infancy. At that time, one in three of the patients seen in the outpatient department had received the ministrations of the itinerant lens coucher, with whom capsulotomy was having a hard struggle to hold its own. In a few years, the Jullundur Hospital had grown to be the largest cataract clinic in the world, solely on the basis of intracapsular extraction, which in the course of three decades has raised the figures for the Punjab and Northwest Frontier to over 20,000 cases annually and has driven the lens coucher from the road and capsulotomy from the hospitals. In the other four provinces in which capsulotomy is still in vogue, the figures have remained almost stationary at about from 12,000 to 14,000 cases annually, and the lens coucher still plies a flourishing trade. A similar tale is told on a smaller scale by the figures for the Bombay Presidency. During two months of the year, at Shikarpur in Sind, Holland performs extractions in the capsule in about 1,500 cases, as many as are done during the whole year in the rest of the Presidency, to which intracapsular extraction has not yet penetrated, and in which the lens coucher's handiwork is still only too painfully evident.

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These are the figures that dominate the situation in the controversy over the relative merits of capsulotomy and intracapsular extraction of cataract. They will admit of only one conclusion, with which there can

Number of Cataract Extractions in Various Parts of India

Year	Punjab, Including N. W. Frontier Province Up to 1913	Total of U. P. Bengal, Madras and Bombay	United Provinces of Agra and Oudh	Bengal, Including Calcutta	Madras Presidency and City	Bombay Presidency and City
1881	265	.....	2,640	357	...	...
1882	507	.....	3,321	350	480	...
1883	435	5,480	4,641	391	255	193
1884	596	7,000	6,048	500	222	230
1885	948	7,451	6,048	763	443	197
1886	1,501	6,683	5,506	551	407	219
1887	2,459	7,093	5,625	635	511	322
1888	2,658	7,855	5,966	893	730	266
1889	3,857	8,988	6,739	1,235	749	265
1890	4,013	11,175	7,615	2,017	1,227	316
1891	4,482	12,521	9,445	1,683	1,103	290
1892	4,294	12,339	8,880	1,597	1,307	355
1893	5,309	12,238	9,124	1,481	1,271	362
1894	5,305	12,269	9,222	1,407	1,233	407
1895	6,216	14,197	10,563	1,913	1,234	487
1896	5,323	13,683	8,923	2,845	1,425	490
1897	4,667	11,102	6,514	3,134	1,562	382
1898	4,534	11,918	5,613	2,560	1,222	523
1899	5,319	10,664	5,734	3,051	1,301	578
1900	5,014	11,202	5,971	2,862	1,472	697
1901	6,590	11,276	5,787	3,159	1,621	709
1902	5,909	11,594	5,335	3,885	1,495	879
1903	6,107	11,504	5,157	3,537	1,418	942
1904	7,465	9,859	5,023	3,514	1,346	1,012
1905	7,929	10,113	4,994	3,053	1,149	917
1906	8,317	12,316	6,421	3,653	1,232	1,010
1907	8,122	11,800	5,568	3,866	1,404	962
1908	8,099	11,815	5,474	4,322	1,034	985
1909	11,156	12,267	5,442	4,145	1,442	1,238
1910	11,397	13,137	6,165	4,266	1,187	1,419
1911	12,290	14,550	6,829	4,953	1,344	1,424
1912	15,576	14,303	8,846	2,464	1,526	1,467
1913	16,236	14,437	9,905	1,291	1,655	1,586
1914	14,907	13,421	8,712	1,391	1,751	1,567
1915	16,457	13,185	8,322	1,357	1,833	1,673
1916	15,542	13,560	8,059	1,283	2,132	2,086
1917	14,794	14,353	7,512	2,772	2,374	1,695
1918	13,112	13,950	7,897	2,554	2,067	1,402
1919	19,008	13,645	6,828	2,329	2,866	1,622
1920	19,721	13,245	5,716	2,308	2,994	2,227
1921	15,092	12,028	4,165	2,170	3,351	2,262
1922	17,488	.....	5,208	.....	3,190	1,942
1923	17,617	14,139	6,019	2,599	3,527	1,994
1924	18,825	14,237	5,758	3,124	4,136	1,224
1925	22,003	18,398	5,500	4,433	5,880	2,585
1926	20,114	16,670	5,946	2,700	5,975	2,049
1927	23,208	19,060	7,012	2,960	6,566	2,522
1928	23,603	18,759	7,129	2,736	6,383	2,511
1929	24,524	18,441	7,513	3,037	5,826	2,065
1930	26,089	19,123	7,705	3,068	6,855	1,495
Population, census 1911	22,171,889	175,238,174	47,182,044	79,973,084	41,405,404	16,672,642

be no quarrel on the grounds that like is not compared with like. (See, for example, the statements made in a recent review in the *British Medical Journal* of the book on cataract by Major Nesfields, I.M.S., Retired,

"We would never allow European eyes to be subjected to the violence to which these Indian eyes can be subjected," and the argument which is always advanced that Indian patients are satisfied with poorer visual results than European patients. This, incidentally, is far from being the case. The peasantry of the Punjab are as highly utilitarian and as exacting in their visual requirements as any peasantry in the world.) Nor can there be any quarrel with such a conclusion on the ground that the cases have not been followed up. They have been followed up by the most impartial and most critical of observers, the patient's own friends, who are themselves contemplating an operation for cataract, and who have no interest in the details of operative technic but are concerned solely with the quality of vision and its endurance. The patient and his friends gather around the village *hookah* and discuss all such matters from every angle with the itinerant priest, who passes on the news from village to village. It is here that the reputation of hospitals is made and lost and the fate of rival operations is decided. These figures are the verdict of the village *hookah* on the matter. They form an argument in favor of extraction in the capsule which cannot be ignored. The obstacle is now removed which in the past has quite rightly prevented the medical profession in the West from adopting intracapsular extraction, namely, that with the more limited opportunities for acquiring the necessary technical skill, there was no method at their disposal with which they could hope to attain success. The latest developments of the Indian method have reduced its technic to a simplicity hitherto undreamed of,[1] which should enable it to be performed by relatively unskilled hands not merely with a lower incidence of loss of vitreous than occurs in capsulotomy when an adequate attempt is made to clear the eye of cortical lens matter, but even without rupture of the hyaloid membrane, which is an inevitable result of interference with an after-cataract.

1. Smith, H.: New Technique for Expression of Cataractous Lens in Its Capsule, Arch. Ophth. **55:213 (May) 1926.**

News and Notes

EDITED BY DR. JOHN HERBERT WAITE

GENERAL NEWS

Jubilee of the French Ophthalmological Society.—The French Ophthalmological Society celebrated the fiftieth anniversary of its foundation in July, and for the occasion, a large number of guests were invited, representing nearly every country in Europe, also Egypt and the United States. The guests who accepted the invitation were entertained at the Hotel Majestic. Among the guests were: Professor and Mrs. Wagenmann (Heidelberg), Professor Krückmann (Berlin), Mr. and Mrs. Leslie Paton (London), Mr. and Mrs. Adams (Oxford), Professor Sachs (Vienna), Professor and Mrs. van Duyse (Ghent), Professor Pascheff (Sofia), Docteur Vogby (Giza, Egypt), Professor and Mrs. Marquez, Dr. and Mrs. Weve Lloveras (Madrid), Dr. and Mrs. Marin Amat (Madrid), Professor and Mrs. Weve (Utrecht), Professor and Mrs. van der Hoeve (Leiden), Dr. and Mrs. Marx (Rotterdam), Professor de Grosz (Budapest), Professor and Mrs. Ovio (Rome) Dr. and Mrs. Lodato (Palermo), Dr. Slavick (Czechoslovakia), Dr. Manolesco (Bucharest), Professor Szymanski (Warsaw), Dr. and Mrs. Patry (Geneva), Dr. and Mrs. Pfluger (Bern) and Dr. and Mrs. Walter Parker (Detroit).

The meetings commenced on Monday, July 18. The mornings were devoted to the more strictly scientific work of the congress, and as the meetings commenced at 8:30, over four hours were allowed for the reading and discussion of papers. In all, seventy-six papers were read, and many of them gave rise to useful discussions. The papers on Monday dealt mostly with diseases of the lids and anterior portions of the eye; many of them were illustrated. On Tuesday morning the general discussion on "The Vitreous" took place. It is the custom of the French Ophthalmological Society to choose a subject for discussion two years ahead and to ask one or two members of the society to prepare reports on the subject, which are published several months before the meeting at which they are to be discussed. This year Redslob, of Strasbourg, and Koby, of Basle, were the two reporters and their papers appeared several months ago, beautifully illustrated. Redslob's title was: "Le corps vitré: son developpement, sa structure, ses propriétés physicochimiques." Koby dealt with "Biomicroscopie du corps vitré." In addition, there were papers by Dejean and Mawas on the same subject, and an interesting discussion followed. Wednesday's papers were mainly on retinal subjects, and, as was to be expected, retinal detachment took a prominent place. Of a total of seventeen papers, nine were devoted directly to this subject. Thursday's program was of a more mixed character. Among the readers were Bailliart, Terson, Onfray, Coppez and Marquez. Coppez' cinematographs of synergic ocular movements were especially interesting.

It is one of the pleasant habits of the French Ophthalmological Society to ask their foreign guests to preside over the meetings, and the

chair was occupied on various occasions by a Spaniard, Professor Marquez, a German, Professor Krückmann, an Austrian, Professor Sachs, a Hungarian, Professor de Grosz, an Italian, Professor Ovio, a Sicilian, Dr. Lodato, a Dutchman, Professor van der Hoeve, and others.

The afternoons and evenings were given up to meetings of a more social nature. The presentation of addresses of congratulation was made at a special meeting on Monday afternoon when the chair was taken by His Excellency, the Minister of Public Health, M. Justin Godard. Paton of London presented an illuminated address on behalf of the Ophthalmological Society of the United Kingdom.

The main addresses from other countries were presented by Krückmann from Germany, Sachs from Austria, van Duyse from Belgium, Marquez from Spain, Weve from Holland, de Grosz from Hungary, Ovio from Italy, Patry from Switzerland, Szymanski from Poland and Parker from the United States. Van der Hoeve spoke on behalf of the International Ophthalmological Council.

René Onfray, secretary-general, gave an eloquent and interesting account of the birth and history of the society.

Later on Monday afternoon the Paris municipal authorities held a reception for the members of the society in the magnificent hall of the Hotel de Ville, and in the evening there was a banquet at the Hotel Majestic, presided over by M. Justin Godard. On this occasion Professor van der Hoeve took the opportunity of presenting, on behalf of the invited guests of the society, a silver chairman's bell, beautifully modeled and engraved.

On Tuesday afternoon, the main social function was an excursion by river to Sèvres and a visit to the state factory of porcelain where everything was done to allow the visitors to see the whole process of manufacture and decoration of the famous ware. Leaving Sèvres, the members went on to St. Cloud, where they dined at the Pavillon Bleu.

On Wednesday afternoon, Dr. Mawas, president of the Ophthalmological Society of Paris, entertained the members at a thé dansant in the salons of the Cercle de l'Union Interalliée.

A performance at the Opera House of "L'Illustre Fregona," with its cheerful exhibition of various Spanish dances, formed a fitting climax on Wednesday evening to a charming series of entertainments.

Clinical Course in Ophthalmology.—The Second Annual Midwinter Clinical Course in Otolaryngology and the First Annual Midwinter Clinical Course in Ophthalmology will be given by the Research Study Club of Los Angeles, Jan. 16 to 27, 1933. Details of the program will be published as soon as completed. For information address Dr. Don Dryer, Secretary, 2007 Wilshire Boulevard. Los Angeles.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Bacteriology and Serology

DIPLOBACILLARY INFECTION. V. MORAX, Ann. d'ocul. **169:** 81 (Feb.) 1932.

This article is a retrospect by Morax on his conjunctival work, especially diplobacillary infection, from 1895 to 1896. It is interesting after thirty-six years of modest research to look back over the road one has traveled. In this connection Morax describes in detail the first case of diplobacillary conjunctivitis that he saw, and how he realized then that the micro-organism that he found differed from the Koch-Weeks bacillus. He also describes how a colleague who has since become eminent volunteered to have his conjunctiva inoculated, and the study that was made following this, of the course and contagiousness of this form of inflammation. Morax was not able to inoculate animals but describes how he was called to examine a chimpanzee, a recent arrival at Bordeaux, and found a well marked diplobacillary conjunctivitis. He then tried to inoculate another one but without success.

Morax, from his observations, does not now believe that diplobacillary infection is confined strictly to the conjunctiva, but is also found in the nose and angles of the mouth. The clinical appearance in the chimpanzee was similar to that found in man.

S. H. MCKEE.

Conjunctiva

NATURAL IMMUNITY OF THE CONJUNCTIVA AFTER BLOCKING THE RETICULO-ENDOTHELIAL SYSTEM WITH TRYPAN BLUE. R. GALLENGA, Arch. di ottal. **39:** 122 (March) 1932.

The reticulo-endothelial system as an important organ of defense against infection is discussed. The work of others has shown a reduction in its activity after repeated injections of dyes the particles of which are retained in the reticulo-endothelial cells. The author wished to study the function of these cells in the conjunctiva. A 1 per cent solution of trypan blue was injected intravenously into rabbits, 5 cc. a day being given on alternate days until 35 cc. had been given. Twenty-four hours after the last injection a fresh broth culture of pneumococcus, type x, was instilled in the conjunctival sac. Untreated animals were inoculated with the same cultures. These controls showed no conjunctivitis, whereas four of five animals that had received trypan blue showed a definite conjunctivitis persisting for a week or longer. A toxic effect of the dye was noted, as all animals lost weight and a number died. The toxic effect was considered a possible factor in the positive inoculations. Animals receiving smaller doses of trypan blue with less toxic effects also developed conjunctivitis of milder type. Animals given trypan blue from twenty-five to thirty-four days

before inoculation, whose toxic symptoms had disappeared, showed no conjunctivitis. Rabbits were chosen for the experiments as animals having a natural resistance to the pneumococcus employed for inoculation. The author concludes that the general toxic effects of trypan blue are probably the most important factor in lowering resistance to infection and not a specific damage to the reticulo-endothelial system by the dye.

S. R. GIFFORD.

THE RELATION OF CONJUNCTIVAL GONORRHEA TO GENITAL GONORRHEA. W. JADASSOHN and K. REHSTEINER, Klin. Wchnschr. **10:** 1902 (Oct. 10) 1931.

A statistical study of conjunctival gonorrhea seen in all ages at the Zurich Clinic reveals only ninety cases during the years 1902-1931.

The following conclusions are offered by the authors from this investigation.

1. The frequency of infantile and adult gonorrheal conjunctivitis (ophthalmia neonatorum not being considered in this work) lies maximally between two and four cases a year from a million population.

2. More than one-half the cases occur in children under 15 years of age.

3. While three fourths of the cases occur in girls, and only one-fourth in boys, there is no difference in the occurrence of the condition in adult men and women. The predominance in girls is traced to gonorrheal vulvovaginitis.

4. About one fifth of all patients with gonorrheal conjunctivitis have no genital gonorrhea.

5. In a comparison of the number of cases of genital gonorrhea in the same age of life, infantile gonorrheal conjunctivitis is forty-five times more frequent than gonorrheal conjunctivitis in the adult.

6. Between the fifteenth and thirty-second years of life, there is a gradual falling off of conjunctival gonorrhea, in relation to the genital gonorrhea.

7. Between the thirty-second and fiftieth years, no case of gonorrheal conjunctivitis was observed.

8. In a comparison of the number of cases of genital gonorrhea in the same age period, gonorrheal conjunctivitis is fourteen times as frequent after the age of 50 as between the ages of 15 and 50.

9. From these statistics it appears that the susceptibility of the conjunctiva for gonococcus infection is dependent on the age period. The susceptibility abounds in youth and falls off toward the fiftieth year of life, again to be increased after this age. From this age disposition the infrequency of gonorrheal conjunctivitis is made clear (insignificant susceptibility at the time of maximum genital gonorrhea) and, at least in part, the relative frequency of gonorrheal conjunctivitis without genital gonorrhea. Charts and a bibliography accompany the article.

L. L. MAYER.

Cornea and Sclera

THE MICRO-ORGANISM OF INDIAN SUPERFICIAL PUNCTATE KERATITIS. H. HERBERT, Brit. J. Ophth. **15:** 633 (Nov.) 1931.

The author comments on the paper on "Superficial Punctate Keratitis" by Wright (*Brit. J. Ophth.* **14:** 257, 1930) in which experimental

evidence was given pointing to a filter-passing virus as the infective agent of the disease, linking it with herpes simplex of the cornea in its varied forms.

He states that thirty years ago he described a causative encapsulated bacillus, but his findings have not been endorsed except by Axenfeld. The bacillus appears to be confined entirely to the more active points of the disease, as defined by fluorescein-staining with a saturated solution made in a rather stronger solution of sodium bicarbonate than laid down. The staining was further enhanced by an intervening cocaine solution, restricting lacrimal secretion. The organism appears to lie exclusively at the surface of the epithelium. The most certain stain was by Gram's method. The capsule was counterstained by the use, for ten to fifteen minutes or more, of a pale diluted borax-methylene blue solution followed by a similarly diluted eosin solution. The average size of the bacillus as given by Axenfeld was 1.5 by 3 microns.

W. ZENTMAYER.

NEW INDICATIONS FOR THE USE OF CONTACT GLASSES. HEINE, Klin. Monatsbl. f. Augenh. **86**: 521 (April) 1931.

New indications for contact glasses are seen by Heine in using umbral tint of the faintest color of 25 per cent for actors, singers and others desiring a cosmetic effect. The darker tints of 50 and 75 per cent are considered suitable against disturbing light, heat or cold, or the glare of snow. These invisible protective glasses will never become steamy, incidentally rendering them practical for sportsmen. Heine furthermore suggests their use against irritating chemical fumes, or trichiasis, or as an invisible "protective bandage" against reinfection in corneal ulcers, coupled with dacryocystitis, or in lagophthalmos.

Discussion of the paper brought forth objections to the use of these glasses by von Hippel, Rieck, Kreutzfeld and others.

K. L. STOLL.

Experimental Pathology

THE ACTION OF E-AVITAMINOSIS ON THE EYES OF RATS. A. JUHÁSZ-SCHÄFFER, Klin. Monatsbl. f. Augenh. **87**: 203 (Aug.) 1931.

A group of rats, observed for nine months, showed the effect of E-avitaminosis, by a hypobiotic process in the testicles of the male, evident by atrophy and necrosis of the germ epithelium, causing sterility. The ovaries of the female rats showed no morphologic changes; the impregnation took place, but the embryos died and underwent intrauterine absorption. E-avitaminosis had no influence on the eyes of these animals.

K. L. STOLL.

General Diseases

STATISTICAL OBSERVATIONS ON OCULAR SYPHILIS. E. PUSCARIU, Arch. d'opht. **48**: 756 (Nov.) 1931.

In this paper the relationship between syphilis and diseases of the eye is discussed by Puscariu under four headings. The first deals with the frequency of syphilis as the cause of ocular disorders. The statistics of Badal, Groenouw, Igersheimer and others are first discussed.

especially from the point of view of the variations in them which will depend on the location of the reporter, especially with regard to the incidence of trachoma. The percentage varies between 0.42 and 10. In the author's hospital series it was 6.9. The frequency of syphilis as compared to other etiologic factors is tabulated as follows: diseases of the cornea, 23.38 per cent; diseases of the iris and ciliary body, 34.68 per cent; diseases of the optic nerve, 43.43 per cent; diseases of the choroid and retina, 32.95 per cent; diseases of the lids, 8.94 per cent, and diseases of the sclera, 49.94 per cent.

The second heading raises the question as to whether serologic diagnosis reveals more cases of syphilis than clinical examination. In the cases studied by the author serologic tests were positive in 78 per cent, whereas clinical evidence of the disease was found in 64 per cent.

Unrecognized syphilis is the third question discussed. The possibility of its presence is pointed out in strabismus as shown by Onfray, in glaucoma by Armoux, Rollet and Colrat and others, and in cataract. The author believes that this disease may account for a number of the postoperative occurrences of iritis. The series of 227 cases studied contained 109 unrecognized cases, or 43.6 per cent. The final topic discussed is the frequency of syphilis as a cause of blindness. The statistics of many different reporters are presented. In the author's series almost one third of the eyes involved in a syphilitic process became blind.

S. B. MARLOW.

THE OCULAR SYMPTOMS OF BUBONIC PLAGUE. CAUGE, Arch. d'opht. 49: 5 (Jan.) 1932.

In an epidemic of plague which occurred in Algiers and its neighborhood between July 11 and Dec. 15, 1930, two cases of iridochoroiditis were observed among a total of seventy-four cases. In only one case was the septicemic form of the disease noted with the development of a terminal bronchopneumonia. The case observed by the author is described. There has been some disagreement as to the frequency with which the eye is effected in this disease. Conjunctival congestion constitutes one of the early signs of the disease as it does in measles and forms one of the triad of symptoms. It is present in nearly all cases. In some it may be so marked as to result in subconjunctival hemorrhages and chemosis. The author believes that the conjunctiva is a portal of entry for the organism in some instances and cites some recorded observations in support of the contention. The ocular changes that may be present are not always due to the presence of the organism, for definite evidence is at hand that shows that these may be due to a toxin. Various structures of the eye may be affected. Intra-ocular optic neuritis has been observed but is rare. Various forms of keratitis are not uncommon. An involvement of the sclera which results in staphyloma has been observed, but of all the ocular manifestations of plague, disease of the uveal tract, next to that of the conjunctiva and cornea, is most common and most serious. It occurs in about 2 per cent of all cases. The appearance of iridochoroiditis in the course of this disease is a serious prognostic sign, not only from the local, but also from the general, point of view. Vision is lost, and even the eye itself may be destroyed. The patient usually dies. It is an indication, perhaps, of the virulence of the disease, the involvement

of the eyes coming on early before resistance can be developed. The administration of specific serum does not prevent their occurrence. There are no particularly characteristic appearances of the iridochoroiditis of this disease. Pustules have been noted on the iris, which are not unlike those seen in leprosy. The study of the second case which occurred in this epidemic in a child showed the nodules seen on the iris before death to contain organisms. The nodules were identical with those formerly thought to be pathognomonic in leprosy. This can, therefore, no longer be considered to be true.

S. B. MARLOW.

General Pathology

THE INFLUENCE OF TUMORS ON THE ADJACENT VESSELS AND ITS CLINICAL IMPORTANCE. A. FUCHS, Klin. Monatsbl. f. Augenh. **86:** 721 (June) 1931.

In view of a number of instances, Fuchs states that so-called newly formed vessels in chronic inflammations are actually capillaries which were present originally, but have undergone telangiectatic dilatation. This process may be due to stasis in some instances, but its origin cannot be explained in the same manner in other instances, e. g., in tumors. The author describes five cases of glioma which show greatly enlarged central retinal vessels, especially veins. This enlargement was striking in the first two cases in which other vessels, presenting thin walls, were also enlarged, some of them forming varicose dilatations in the trunk of the optic nerve. The vessels of the retina and iris were likewise enlarged in the first case in which the tumor had not involved the optic nerve. An abundance of vessels, on the other hand, was found in the second case in which the tumor had invaded the optic nerve. A similar condition was observed in two cases published by Koyanagi. Angioma was ruled out in all of these cases by Fuchs. He is of the opinion that capillaries, extended by an excess quantity of blood, have formed these telangiectases. The stimulus for this development is produced by the growth of the tumor in a manner that is known to cause proliferation in the tissues surrounding a tumor. Growth of the tumor masses as a stimulus would explain the growth of the stroma between the carcinomatous nests, or the dilatation of the ciliary vessels in a tumor of the choroid, and the development of a convolution of vessels on the sclera corresponding to the site of a sarcoma of the ciliary body. Hippel's disease, on the other hand, represents angiomatosis.

Fuchs thinks that the growth of the vessels is stimulated by a substance originating in the primary tumor and entering the lymph sheaths of the vessels. This view is supported by the fact that the vessels are pathologically changed in Hippel's disease, and also in the episcleral convolutions of vessels accompanying the sarcoma of the ciliary body described by Fuchs.

K. L. STOLL.

Glaucoma

THE EFFECT OF SUBCUTANEOUS INJECTIONS OF ERGOTAMINE TARTRATE (GYNERGEN BRAND) ON THE TENSION IN GLAUCOMA. SIGURD WERNER, Acta ophth. **9:** 275, 1931.

A comprehensive review of the use of ergotamine tartrate (gynergen) is given by Werner. In a group of fifteen patients 0.5 cm. of the drug

was given subcutaneously three times daily over a period of from three to seven days. The results were not encouraging for the tension was reduced to normal in only one instance, and that was a case of secondary glaucoma. Twelve of the foregoing patients were subsequently treated with miotics, but the tension could not be reduced to normal. Werner was not impressed with the subcutaneous injection of ergotamine tartrate for the reduction of intra-ocular tension in glaucoma simplex.

A. M. YUDKIN.

Injuries

LESIONS OF THE EYE CAUSED BY STINGS OF BEES AND WASPS: REPORT OF CASES. J. STREBEL, Klin. Monatsbl. f. Augenh. **86:** 657 (May) 1931.

The author reports two of several cases of bee and wasp stings which came under his observation. Both patients, a boy, aged 2, and a man, aged 21, were stung in the cornea. Severe purulent inflammation developed in the boy, which, however, cleared completely, as it was of a toxic chemical nature and was free from bacteria. The sting remained in the cornea, and had caused no disturbance since 1928. The eye of the young man, who was stung by a bee in 1924, became blind, when a secondary infection produced seclusion of the pupil and calcareous cataract. The poison of the sting, containing formic acid, may be considered a disinfectant. It can be neutralized by chloride or preparations that form oxygen. Therefore, the supposed site of the sting should be touched repeatedly with hydrogen peroxide, or hydrogen chloride. Even larger quantities of the poison are harmless for the eye and its interior. Stings of bees may remain within the cornea permanently without causing irritation, even if they protrude into the anterior chamber. However, in such cases repeated puncture of the anterior chamber is recommended by the author, combined with efforts to remove the sting. A cystotome will be of greater value than forceps, which may cause the chitin of the sting to break.

Experiments performed by the author proved that the contents of formic acid in the poison of the sting will not injure the eye and that strong solutions of formic acid, when introduced into the anterior chamber, will not produce cataracts.

K. L. STOLL.

LESIONS CAUSED BY POISON GAS (DICHLORETHYLSULFID: PRESENTATION OF A CASE. SCHOELER, Klin. Monatsbl. f. Augenh. **86:** 681 (May) 1931.

A few hours after he had cleansed a container of yellow-cross gas, the patient showed pathologic symptoms of the kidneys, liver and lungs, besides extensive dermatitis and membranous conjunctivitis with desquamation of large shreds. Keratitis followed. Recovery was brought about by injections of diphtheria serum, thorough cleansing of the skin, close shaving and the application of sodium bicarbonate, permanganate of potassium, silver nitrate and alkali ocular salves. The skin was still pigmented and an erosion existed on the right cornea seven weeks after the accident.

K. L. STOLL.

Lacrimal Apparatus

EXPERIENCES GATHERED FROM 517 DACRYOCYSTORHINOSTOMIES. GÓMEZ-MÁRQUEZ, Klin. Monatsbl. f. Augenh. **86:** 620 (May) 1931.

This paper is a continuation of three prior publications by the author on the same operation, which he has practiced since 1924. His first paper contained the description of a crown-shaped instrument, devised by Gómez-Márquez, to replace the chisel and burr. The second paper reported results obtained through the operation in cases of serpent ulcer of the cornea, proving the possibility of replacing enucleation of the tear sac by this method. The third paper brought a résumé of permanent results obtained until 1928. The present paper gives a detailed description of the technic and the instruments used. Ninety-eight per cent of Gómez-Márquez' patients were cured. He eliminated as unfit for the operation all persons with ulceration or tuberculosis of the tear sac, with active fetid rhinitis, as well as persons with inoperable diseases of the nose. Whenever suppuration and gangrenous conditions of the mucous membrane were noticed during the first week after the operation, they were attributed to faulty technic. Results may be considered permanent if obtained within a month after the operation; they are demonstrated by the velocity with which staining fluid, instilled in the eye, reappears in the nasal secretion, and by the absence of epiphora.

Dacryocystorhinostomy requires patience and time; it may cause profuse hemorrhage which may resist the experience and skill of any surgeon. It is, however, in the author's opinion, the moral duty of every oculist to practice it for the benefit of his patients.

K. L. STOLL.

Lens

CATARACT FORMATION AND THE PHOTOCHEMICAL EFFECT OF SULPHYDRIL COMPOUNDS. G. KÖGEL, Arch. f. Ophth. **126:** 502, 1931.

It has been known for a long time that the cataractous lens contains no sulphydril compounds that are important for the hydrogen and oxygen metabolism of tissues. Kögel found that sulphydril compounds are able to transfer oxygen by activation of their own hydrogen in the HS radical under the influence of light. He suggests to treat patients with cataract with sulphydril compounds, among which he recommends the glucothiose, a compound of a pentose with the HS radical.

P. C. KRONFELD.

CHRONIC ECZEMA AND CATARACT: REPORT OF A CASE. G. LEVY, Klin. Monatsbl. f. Augenh. **86:** 681 (May) 1931.

A man, aged 23, had suffered from many attacks of eczema since his sixth year of life. After a free interval of two years, the eczema had recently returned. Simultaneously the left eye presented an advanced cataract, and the right eye, subcapsular opacities, somewhat star-shaped in the posterior cortical, a few dotted opacities in the nucleus and a few opacities in the vitreous. A connection is seen by the author between the cataracts and the eczema, which may be termed neurodermatitis in this case, both being caused by endocrine dysfunction.

The evolutionary relationship between lens and skin seems to suggest that the same endocrine dysfunction would manifest itself as eczema in the skin and as cataract in the lens. Publications in point by Rothermund, Andogsky, Loewenstein, Vogt and Kurz are referred to.

K. L. STOLL.

Methods of Examination

TONOMETRY BEFORE AND AFTER CATARACT EXTRACTION. H. FERRER, Arch. de oftal. hispano-am. **32:** 141 (March) 1932.

The author refers to his claims of priority in recommending a preliminary tonometry in all cases of cataract extraction, by which means valuable operative indications can be drawn. When the tension is low, he advises a preliminary dilatation of the pupil. When the tension is normal, he dilates the pupil by instilling atropine one hour before the operation. When the tension is somewhat high, he uses a prior retrobulbar injection of procaine hydrochloride and epinephrine. When hypertony is pronounced, he prefers a preliminary iridectomy. In these cases he considers atropine contraindicated before and after the operation, to the systematic use of which after the operation he attributes most of the cases of postoperative glaucoma.

After cataract extraction, great variations in ocular tension are observable. A reduction in tension usually indicates iritic inflammation. An increase generally is due to swelling of lens remnants and imbibition of vitreous with aqueous. In the former case mydriatics are indicated; in the latter, myotics.

He criticizes the preliminary instillation of atropine in discission of secondary cataract, blaming it for the occurrence of most of the cases of glaucoma after discission of secondary cataract.

C. E. FINLAY.

Neurology

UNUSUAL SURGICAL LESIONS AFFECTING THE OPTIC NERVES AND CHIASM. J. R. LEARMONTH, W. I. LILLIE and J. W. KERNOHAN, Am. J. Ophth. **14:** 738 (Aug.) 1931.

The following cases are reported: (1) meningioma en plaque, simulating a basofrontal meningioma; (2) epidermoid cyst between the frontal lobes; (3) glioma of the third ventricle; (4) cystic tumor of the hypophysis, associated with a cyst of the right optic nerve; (5) tumor of the vermis, and (6) perineural fibroblastoma of the left eighth cranial nerve. These cases are discussed particularly from the ophthalmologic standpoint, and the following summary is given.

Six cases are presented, in which the ophthalmologic features were associated either with tumors of an unusual type, or with tumors in unusual situations. The clinical and surgical features of each case, and in two cases the findings at necropsy, are considered.

W. S. REESE.

Ocular Muscles

DIVERGENCE PARALYSIS. H. J. HOWARD, Am. J. Ophth. **14:** 736 (Aug.) 1931.

The case of a 71 year old woman, admitted for carcinoma of the breast, is reported. Two months prior to admission diplopia occurred

following a severe pain in the left side of the neck and the occipital region. The roentgenographic diagnosis was metastatic tumor of the cranium. Examination revealed diplopia at and beyond 1 meter, but not inside this distance. This diplopia was homonymous, and the images maintained the same distance from each other in all fields. The patient unfortunately was lost from observation.

W. S. REESE.

Operations

A NONOPERATIVE METHOD OF DILATATION OF THE CONJUNCTIVAL SAC IN ANOPHTHALMOS. Y. PRIJIBYLSKAYA, Russk. j. opht. **13:** 493 (May-June) 1931.

The author reports sixteen cases of anophthalmos in which nonoperative dilatation of the sac was used. The conjunctival sac, though present in all cases, was diminished in all directions, so that the smallest prothesis could not be worn. This method is not new, but it is simple and accessible; the patient does not need hospitalization and can continue his work. The author followed the cases for eight years. In all but one case the treatment was successful.

The author uses a lead plate, covering it with paraffin of a high melting point. The lead plate is shaped according to the approximate size of the conjunctival cavity and has a biconvex surface. The hardened plate is put into the cocainized conjunctival sac; the patient is told to close the eyes, and the excess of the paraffin is removed. It is necessary to wear the plate about three weeks in order to dilate the sac. A small prothesis is worn, being replaced gradually by larger protheses; the patient wears the prothesis at first day and night, taking it out only for cleansing of the conjunctival cavity.

O. SITCHEVSKA.

Orbit, Eyeball and Accessory Sinuses

PROGRESSIVE EXOPHTHALMOS FOLLOWING EXTIRPATION OF THE THYROID GLAND. (THE ASSOCIATION BETWEEN THE THYROID AND PITUITARY GLAND.) HERMAN STEWENS, Ztschr. f. Augenh. **75:** 137 (Sept.) 1931.

Stewens describes a case in which exophthalmos and considerable edema of the conjunctiva were present after the thyroid gland was removed. From a survey of the literature the author notes that the proptosis rarely disappears in exophthalmic goiter after the extirpation of the thyroid gland and frequently the soft tissue of the eyeball becomes edematous. This manifestation has been attributed to an insufficiency of thyroid secretion. In the author's case, the administration of thyroxine increased the exophthalmos and produced more chemosis, and manifestations of hyperthyroidism appeared. An Abderhalden test of the blood revealed a deficiency of hypophyseal secretion. A roentgenogram of the head showed an abnormally small sella turcica. Because of these findings, the patient was treated with a preparation containing solution of pituitary. A gradual disappearance of all symptoms was observed.

A. M. YUDKIN.

Pharmacology

SOME INTERESTING EXPERIENCES IN THE CLINICAL PHARMACOLOGY OF THE EYE. D. I. MACHT, Am. J. Ophth. **14:** 726 (Aug.) 1931.

Cases in which properly prepared prescriptions acted unexpectedly are cited. A solution of physostigmine (eserine) and pilocarpine caused mydriasis, and one of homatropine resulted in extreme and prolonged mydriasis. A solution of pilocarpine was found irritating because of sensitivity to small differences in hydrogen ion concentration. The following summary is given:

The foregoing cases are presented because of their interest as emphasizing the following practical points:

1. The occurrence of abnormal physiologic effects after the use of certain important alkaloids in ophthalmologic practice, more particularly of physostigmine (eserine) and pilocarpine.

2. The great variations in potency and effectiveness of various specimens of homatropine on the market.

3. The importance of applied pharmacology in connection with ophthalmologic therapeutics.

4. The extreme delicacy of certain pharmacologic tests as compared with physical and chemical examination of powerful drugs, especially in regard to the detection of contaminations and variations in their therapeutic potency.

5. The importance of constantly bearing in mind the idiosyncrasies and extreme sensitiveness on the part of patients to even very small differences in the composition of prescriptions. W. S. REESE.

LOCAL ANESTHETICS: A CRITICAL SURVEY OF OLD AND NEW PREPARATIONS. E. REHN and H. KILLIAN, München. med. Wchnschr. **79:** 545 (April 1) 1932.

A large number of German local anesthetics were studied from both an experimental and a clinical angle. Of interest in ophthalmology are the conclusions reached in regard to infiltration anesthesia and local corneal sensitivity. In experiments on rabbits it was shown that subcutaneous injection of the following drugs caused the least toxicity: procaine hydrochloride, eucaine hydrochloride, tropococaine, p-aminobenzoyl-N-diethylleucinol-methanesulphonate and tutocaine, in the order named. The hydrogen ion concentration was investigated, and it was demonstrated that in subcutaneous injection of a drug this factor was of little or no importance. However, in topical applications a p_H of 7.3 is advised, whether or not epinephrine is combined with the chosen anesthetic. Comparative curves in regard to time and strength of concentration of the drug show that nupercain, p-butylaminobenzoyldimethylaminoethanol hydrochloride and p-aminobenzoyl-2-2-dimethyl-3-diethylaminopropanol hydrochloride, even in the greater dilutions, have a more rapid and lasting anesthetic effect on the rabbit's cornea. Tables and curves accompany the article. L. L. MAYER.

Physiology

SPECTROSCOPIC STUDIES OF THE FUNDUS. M. BAURMANN, Arch. f. Ophth. **126:** 536, 1931.

The purpose of these studies is to determine the proportion of oxyhemoglobin and reduced hemoglobin in the blood of the chorio-capillaris. So far the author has found only that the the absorption spectrum of the light reflected from the fundus is mainly a hemoglobin spectrum and is only to a very slight degree modified by the retinal pigment (in contradiction to E. Marx).

P. C. KRONFELD.

EXPERIMENTAL STUDIES OF THE "LIGHT TONE" OF MAN AND RABBIT. E. METZGER, Arch. f. Ophth. **127:** 296, 1931.

If light is thrown in one eye, man and rabbit show increased tone in all the muscles of that side, which manifests itself in a tendency to fall, increased tone of the arm and faulty pointing at objects. A walking person deviates toward the side of the stimulated eye. The effect of light on the muscular tone depends on its intensity and wavelength. The retinal processes that follow the direct action of a light stimulus (after-images) also modify the muscular tone. The same changes in tone are observed if the left and right half of one eye are alternatingly stimulated. If optic stimuli are moved across the retina (fixed gaze and moving objects), variations of the general muscle tone also occur. These experiments show that there are definite relations between the visual organ and the static apparatus. The author believes that further studies of the "light tone" will furnish the physiologic basis for constructing an undivided and tactile space.

P. C. KRONFELD.

Refraction and Accommodation

ANGINA CAPITIS. I. P. MICHAELSON, Brit. J. Ophth. **16:** 202 (April) 1932.

A hundred consecutive cases of headache due to refractive errors were collected with the object of investigating the mechanism by which the ocular headache arises.

A résumé has been made of the chief known facts of referred visceral pain, physiologic, clinical and experimental. A study has been made of the activity and innervation of the ciliary muscle, of the clinical features of ocular headaches and of an experimental relationship between the skin and ciliary muscles. The author's conclusion is that there has been shown a sufficient concurrence between both sets of facts to justify the suggestion that the mechanism underlying ciliary headache is analogous to that which gives rise to referred visceral pain in other parts of the body.

W. ZENTMAYER.

THE HUMAN REFRACTION CURVE. P. C. KRONFELD and C. DEVNEY, Arch. f. Ophth. **126:** 487, 1931.

A clinical material of 2,229 eyes was used for the construction of a new refraction curve. The age of the patients was between 25 and 50.

The refraction was done under atropine cycloplegia, and the total astigmatism was not greater than 0.5 diopter. The curve differed from that of Scheerer and Betsch as the latter had fewer cases with a refraction from —2 to —4. The authors believed that the figures of Scheerer were correct because they were obtained from a nonselected population. Therefore Kronfeld and Devney corrected their curve accordingly and then found it to be almost symmetrical. There was, however, a slight deviation which may express the influence of "anlage" factors or of living conditions.

The human refraction curve differs in one respect from the binomial equation, namely, in its high excess which is due to too great a frequency of extreme variants and also to too great a frequency of average or "normal" eyes. The latter fact is the result of a definite correlation between refractive power and axial length of the human eye (Straub, Zeeman, Tron).

Steiger's theory of the origin of the various refractions by free, independent combinations of the refractive elements should be modified accordingly.

P. C. KRONFELD.

Retina and Optic Nerve

ACUTE CHOKED DISK. DE MARTEL, MONBRUN and GUILLAUME, Arch. d'opht. **48:** 678 (Oct.) 1931.

Under this title the authors group a series of observations which they believe to be a hitherto unrecognized syndrome. Acute choked disk demands urgent intervention. All the cases the authors have observed confirmed the clinical diagnosis of tumor in the posterior fossa with markedly increased intracranial pressure associated with dilatation of the lateral ventricles and the third ventricle, due to blockage. They point out that in the past ophthalmoscopic examinations have not commonly been made more than once. Repeated examinations are essential if the various stages of development of choked disk are to be observed. The third stage, with enormous edema, filiform arteries, engorged veins and surrounding hemorrhages, is what is seen in acute choked disk. It may appear within forty-eight hours, or sometimes the next day after an ophthalmoscopic examination has revealed a normal or slightly swollen disk. Vision remains unaffected, but the pupillary reactions become sluggish. Nine case histories are presented in all of which lesions were found in the posterior portion of the brain. They have never seen this phenomenon in cases with lesions in other locations. Because of their belief that acute choked disk is a manifestation of acute dilatation of the ventricles due to blockage, with its attendant severe general symptoms, early operation is urgent. This should be done in two stages: first, a cerebellar decompression and next, the extirpation of the tumor.

S. B. MARLOW.

THE PATHOGENESIS OF PIGMENTARY DEGENERATION OF THE RETINA. Y. KOYANAGI, Arch. f. Ophth. **127:** 1, 1931

Retinitis pigmentosa is almost generally (following Stock) thought to be a primary degeneration of the neuro-epithelium. This view is, according to Koyanagi, mainly based on the fact that the choroidal ves-

sels were found to be normal in a large number of cases available for histologic examination. The author studied two pairs of eyes anatomically. The first patient (a man, aged 67) showed the typical ophthalmoscopic picture of retinitis pigmentosa. The sections revealed severe atrophy of the entire retina, though more marked in the outer layers. The retina was firmly adherent to the lamina vitrea. Retinal and choroidal arteries were scarce and showed thickened walls (sclerosis of the intima in the choroid). The choriocapillaris was missing completely in places; in other areas, however, it was well preserved.

The second case was that of a woman, aged 74, who had been blind for the last twenty years of her life. She died from a rupture of a syphilitic aneurysm. Her eyes showed an old syphilitic choroiditis which appeared under the typical picture of pigmentary degeneration. Koyanagi assumes that the cause of the pigmentary degeneration in the second case was the severe syphilitic vascular process in the choroid. The first showed similar vascular changes, although not on a syphilitic basis.

After giving amyl nitrite to patients with retinitis pigmentosa with and without pigment in the retina, Koyanagi observed visible dilatation of the retinal vessels and transient improvement of the visual fields. He sets forth the theory that the ophthalmoscopically visible narrowing of the arteries in the two conditions mentioned indicates a vascular spasm of unknown cause. If this spasm persists long enough, it produces anatomic changes. Koyanagi prefers this angiospastic theory to Stock's idea of primary idiopathic degeneration. P. C. KRONFELD.

TREATMENT OF OPTIC ATROPHY BY RETROBULBAR INJECTIONS OF ATROPINE. A. A. ABBASOFF, Russk. j. opht. **14:** 367 (Oct.-Nov.) 1931.

This treatment is based on the supposed stimulation of function of nerve tissue which is not completely atrophic. The author treated seventeen patients with atrophy of the optic nerve of various etiology. Ten retrobulbar injections of atropine sulphate of 1 : 1,000 solution are given twice a week. The dose is 0.5 cc. on the first injection, 0.8 cc. on the second and 1 cc. on the following injections. In one patient only symptoms of poisoning, dryness of the mouth and difficult deglutition were observed. The visual field was improved from 5 to 15 degrees in five patients; in one of these the bitemporal hemianopia disappeared for a period of ten months. In three patients the color perception was restored after the course of injections was completed. The vision was improved in five patients from finger counting to 0.1-0.9.

The author believes that in recent processes the injections of atropine are of considerable value. The injections do not cause dilatation of the retinal vessels or hyperemia of the optic disk. O. SITCHEVSKA.

Trachoma

HEMATOLOGY OF TRACHOMA. FRANÇOIS, Arch. d'opht. **48:** 549 (Aug.) 1931.

The author reports the results obtained in the examination of the blood in fifty cases of trachoma, twenty in the active follicular stage and

thirty in the cicatricial. In the majority of cases he found some lowering of the hemoglobin. In more than 80 per cent there was a slight anemia, which in 50 per cent of these cases was with a high color index. The leukocyte count showed nothing characteristic in the active cases, but in the cicatricial there was a definite tendency toward leukocytosis. There was a contant neutropenia compensated by a lymphocytosis and monocytosis. Eosinophils were found in 75 per cent of the follicular cases and in barely 25 per cent of the cicatricial. These findings led the author to believe that trachoma is not a purely local condition but follows, or at least is accompanied by, some general disorder. His results confirm, he thinks, the belief of Angelucci that trachoma develops only in an adenolymphatic terrain.

S. B. MARLOW.

Tumors

EPIBULBAR NEVO-CARCINOMA WITH ALMOST TOTAL CORNEAL INVOLVEMENT. R. CASTROVIEJO AND R. CASTROVIEJO, JR., Am. J. Ophth. 14: 757 (Aug.) 1931.

The authors remark that not many of the published cases of epibulbar tumors contain complete and demonstrative histologic reports. They believe that most of these tumors are nevocarcinomas rather than melanosarcomas. A number of authors are quoted who have considered these tumors nevic in origin, and who have furthered this belief. They report the case of a woman, aged 62, with a growth on the left eye. This first appeared three years previously as a little red spot which remained stationary in size for two years, but then rapidly invaded the cornea. Examination revealed a tumor covering all the cornea except a sector 4 by 4 mm. to the nasal side. It extended 3 mm. outside the temporal limbus and reached the nasal limbus above and below, forming a horseshoe-shaped mass. The tumor was flattened and elevated about 2 mm. over the central part of the cornea to which it was intimately adherent. It was whitish in color, slightly pink in places and of medium consistence and lardaceous aspect. The biomicroscope revealed brownish striations on the tumor, especially below. A diagnosis of melanosarcoma of the cornea-conjunctiva was made, and the eye enucleated. A complete microscopic examination was made, and the following conclusions are given:

1. The pigmented cells found in the epithelium are not different from the nevic cells; therefore, it is logical to suppose that these cells, located always superficially and near the epithelium, might be epithelial cells detached into the connective tissue.

2. All the melanic cells in the tumor proceed from epithelial cells, those found in the tumor lobules as well as those existing in the connective stroma.

3. Study of the zone of propagation of the tumor and the successive transformation of the epithelial cells show that it is not a tumor of connective tissue origin but purely epithelial.

4. The tumor has its probable origin in one of the nevic cells of the limbus (as seems to be demonstrated by the clinical history), with successive transformation of the rest of the epithelial cells of the cornea, and belongs, therefore, to the type called nevocarcinoma.

5. In most, if not all, of the tumors described in the literature as epibulbar melanosarcomas, it might have been possible to demonstrate, after a careful microscopic examination, details of structure that would permit of their classification under the type herein described.

An extensive bibliography is appended. W. S. REESE.

Vision

A NEW INTERNATIONAL VISUAL ACUITY CHART. L. DOR, Arch. d'opht. **48:** 484 (July) 1931.

The author points out that a visual acuity test made up of letters not only cannot be used internationally but also cannot be constructed on strictly scientific principles. The charts proposed by Landolt and Pfluger, although more scientific, are not satisfactory in the presence of astigmatism. Dor presents a series of black dots and squares which overcome most of these difficulties. He has combined the decimal scale of Monoyer and the classic form. He has also arranged the graduations to conform to the suggestions of M. Coppez. S. B. MARLOW.

Visual Tracts and Fields

THE VISUAL FIELD OF FATIGUE IN MELANCHOLIA. L. MAGGI, Arch. di ottal. **39:** 86 (Feb.); 99 (March) 1932.

The author reviews present theories which attempt to explain the characteristic spiral fields of neurasthenia. He reports a series of examinations of patients with melancholia with a modern perimeter including a device by which the visual acuity could be estimated in various parts of the field by Lo Cascio's method. Twenty patients were chosen without any known ocular pathologic process. Three or four fields were recorded successively for one eye and after a half-hour rest; for the other eye, the target was moved from without in. This was repeated on successive days, the target being moved from within out. On later days the vision at 25 and 45 degrees in the principal axes was determined.

The fields varied greatly when repeated at different times. No spiral fields were obtained, but more often later fields proved larger than the one first taken, indicating the effect of training in attention to the object. No changes in form or color fields were found that would be considered characteristic of the disease. The peripheral visual acuity showed no marked changes from the normal. S. R. GIFFORD.

Vitreous

FRAGMENT OF COPPER WIRE IN THE VITREOUS. P. G. MOORE, Am. J. Ophth. **14:** 750 (Aug.) 1931.

A case is reported in which a piece of copper was removed from the bottom of the vitreous chamber through scleral incision, light being thrown into the pupil so that both the forceps and foreign body could be seen. Recovery was uneventful, and the final corrected vision was 6/7.5.

W. S. REESE.

Society Transactions

EDITED BY DR. JOHN HERBERT WAITE

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Feb. 18, 1932

LEIGHTON F. APPLEMAN, M.D., *Chairman*

UNILATERAL NEURORETINITIS OF SYPHILITIC ORIGIN WITH A STELLATE FIGURE AT THE MACULA. DR. A. G. FEWELL.

A colored woman, aged 35, was first seen in the eye dispensary of the University Hospital on Dec. 15, 1931. Vision in the right eye had failed rapidly for the past two weeks to 3/45. There was no history of injury. Fine vitreous opacities were present. The disk was hyperemic, and the margins were hazy, with fine striations extending out into the retina. Near the upper temporal margin of the disk there was one small hemorrhage. The veins were dark and overfilled, and both veins and arteries were somewhat tortuous. At the macula there was a perfect stellate figure. The left eye was normal. All medical studies gave negative results except for a positive Wassermann reaction. The patient had had eight injections of neoarsphenamine and two of bismuth. The condition was rapidly clearing up, the neuritis and hemorrhage having entirely disappeared, and the stellate figure was much less pronounced. At the time of presentation, the vision in the right eye was 6/9. The case was presented because stellate figures are rarely seen in syphilis, although they are common in renal disease, and are fairly common in cases of intracranial pressure due to a tumor of the brain.

DISCUSSION

DR. T. B. HOLLOWAY: Stellate figures are always interesting to those devoted to ophthalmoscopy.

In addition to the conditions referred to by Dr. Fewell, the lesion is also noted in certain cases of anemia, and I believe Dr. de Schweinitz recorded the observation in a case of chlorosis. I have seen three cases in which the figure developed following a double perforation of the globe by a foreign body, with the wound of exit near the margin of the macular region. This is the only instance in which I have seen it as a syphilitic manifestation. While I have observed my share of diabetic manifestations, it was only recently that I saw a patient with a well formed stellate figure, and in this patient the rays were absent between 2 and 4 o'clock, but were perfect elsewhere. Despite the various conditions with which it may be associated, I regard it as rare except in cases associated with choked disk, for which Paton cited an incidence of 15 per cent, and in renal disease for which, if I remember correctly, Slocum's figures were between 6 and 7 per cent.

Dr. William Zentmayer: I recall having seen a macular figure in a case of syphilitic neuroretinitis in a Negro child. It did not have the typical fan shape, but the round yellow lesions were arranged in concentric circles about the fovea.

Enucleation of the Eyeball, with Special Reference to the Use of a Tonsil Snare. Dr. Luther C. Peter.

Dr. Peter presented a new method of enucleation of the eyeball, which may be used under local or general anesthesia.

The conjunctiva is detached pericorneally; the four recti muscles are severed close to the globe, with the exception of the external rectus, which is cut so as to leave a stump of about 4 mm. To this stump are attached clamp forceps for the further manipulation of the eyeball. After the conjunctiva is thoroughly detached from the globe, a Lewis tonsil snare, threaded with no. 8 wire, is introduced from the temporal side, the loop being depressed first on the nasal side and then on the temporal side, and the snare being slowly tightened until the oblique muscles, the optic nerve and the vessels are severed. If the globe is ruptured or there is any danger of rupture from any undue pressure, it is avisable to sever the attachments of the oblique muscles by means of curved scissors before the snare is applied. The important phases in the use of the snare are the no. 8 wire, which crushes rather than cuts the tissues, and the deliberate tightening of the snare.

Discussion

Dr. E. B. Spaeth: In the practice of enucleation with a snare, there are two points worth mentioning: The operation is bloodless, for the procedure is carried on in a perfectly dry field without the necessity of constant sponging, and hence with a much lessened danger of possible infection. The second point is the ease with which one can get a long nerve stump, for with the snare slowly coaxed back a long stump can be taken out readily.

Dr. William Zentmayer: I am pleased that Dr. Peter has called attention to the use of the snare in the operation of enucleation of the eyeball, as it is clear from the speaker's experience that in certain conditions it is of distinct value. It seems strange that it has not been more in use, since as early as 1914 H. R. Wright pointed out its advantages in securing a bloodless field for inserting conjunctival sutures. I believe that Dr. Fisher of Chicago has for some years employed this method.

A Case of Bilateral Metastatic Carcinoma of the Choroid. Dr. William Zentmayer.

The diagnosis of the ocular condition in the case presented lacked pathologic confirmation, but the ophthalmoscopic findings in conjunction with the case history seemed sufficient evidence on which to base the diagnosis of bilateral metastatic carcinoma of the choroid.

S. M., a woman, aged 60, consulted me on June 20, 1930, because of failing vision and night blindness, which she had first noticed early in February, 1930. There was neither ocular pain nor discomfort. Increasing axial hypermetropia appeared to have taken place, judged by the records of attending oculists.

Beginning on the nasal side of the disk near the superior vessels and sweeping around above the disk and macula, far out into the temporal area, where it extended into the inferior part of the fundus, was a uniformly flat, yellowish-gray infiltration of the choroid which produced a solid detachment of the retina. The general level of the involved area was about plus 5 diopters. In some places it measured plus 7 diopters. The fundus level was plus 2 diopters. All of the retinal vessels, especially the arteries, were diminished in size.

The media of the left eye were clear. The disk was vertically oval. The fundus presented much the same appearance as that of the right eye, but the area involved was not so extensive. Between the disk and the macula there was a more or less circumscribed area with a mottled surface, on which were small hemorrhages with new vessel formation. These were probably due to emboli of carcinomatous cells, such as were found histologically in Archangehky's case. Along the temporal vessels were areas of yellowish-white degeneration or infiltration of the retina.

Dr. de Schweinitz saw the case and agreed that the lesions were indicative of metastasis from the breast. He advised a series of radium treatments of the eyes. One such treatment was given by Dr. P. B. Widmann on July 26.

The general medical history was that a uterine fibroid had been removed in 1925. The left breast was removed radically on Jan. 20, 1928. The pathologic report was scirrhous carcinoma of the mammary gland with metastasis to the regional lymph nodes. Three series of roentgen treatments were applied to the area of the left side of the chest during the ensuing eighteen months. A roentgenogram taken on Sept. 20, 1929, showed metastasis involving the lower half of the left pulmonary area and practically all the spine, with metastatic areas in the left lung and in the liver.

In 1908, Suker and Grosvenor collected sixty-four cases from the literature. The proportion of females to males in these cases was 3 to 1. Since 1908, thirty-two cases have appeared in the literature. In this series the proportion of female to male patients is 3 to 1, and that of unilateral to bilateral cases, 3 to 2. In a large majority of cases the metastasis was from the mammary glands.

DISCUSSION

DR. GEORGE E. DE SCHWEINITZ: I have examined two undoubted cases of metastatic carcinoma of the choroid, each unilateral, one being studied microscopically, and one case (bilateral) in which the diagnosis was somewhat uncertain. In two of these patients, both women, the choroidal lesions represented metastasis from a carcinoma of the mammary gland.

The metastasis appears to take place through the posterior ciliary arteries and, as the essayist has pointed out, is most frequently from a carcinoma of the mammary gland (thirty-nine times in sixty-four cases collected by Suker and Grosvenor; sixty-five times in ninety cases collected by Usher).

METASTATIC SARCOMA OF THE CHOROID. DR. W. E. FRY.

This article will appear in full in a later issue of the ARCHIVES.

March 17, 1932

LEIGHTON F. APPLEMAN, M.D., *Chairman*

INTRA-OCULAR SARCOMA WHICH FILLED THE ORBIT BEFORE MEDICAL ADVICE WAS SOUGHT. DR. H. MAXWELL LANGDON.

A man, aged 45, had noticed failing vision in his right eye for two years and complete blindness for one year. The eye became greatly enlarged, being about three times its normal size. There was no ocular pain until the day before he went to the hospital.

Roentgen examination showed the orbit filled with new tissue, without involvement of the sinuses. The orbit was exenterated, and healing was uneventful. The patient died two years later, probably of metastasis to the liver.

SARCOMA OF THE CHOROID. DR. T. B. HOLLOWAY.

A man, aged 23, gave a history of having had his right eye struck by a hammer three years prior to presentation, without an inflammatory reaction. One year later vision in this eye became impaired, and bad grown steadily worse. On seeking medical advice, he was advised that he had a detachment of the retina.

Beginning about a half disk diameter from the temporal side of the right disk, there was a large round and well circumscribed solid detachment of the retina, which extended over the macular region and far toward the periphery of the eyeground. Deep vessels were rather conspicuous over the summit of the growth, and in several places small vague areas of pigmentation were seen. The apex of the detachment could be clearly seen with a plus 20 diopter lens. It was thought that the conditions present showed a typical picture of sarcoma.

The field showed a slight contraction with practically a complete loss of the whole inferior nasal quadrant extending to the blind spot. Enucleation was advised. The left eye was normal.

DIAGNOSIS OF DOUBLE PERFORATION OF THE GLOBE BY THE INJECTION OF AIR INTO THE SPACE OF TENON. DR. E. W. SPACKMAN.

Dr. Spackman described a method by which air is injected into Tenon's capsule, making it possible by roentgen examination to determine whether the foreign body has perforated the posterior sclera or remains within the globe.

The complete paper will appear in the *American Journal of Ophthalmology*.

DISCUSSION

DR. WARREN S. REESE: The Sweet method of localization of intraocular foreign bodies is accurate. Inaccuracies in localization arise from incorrect clinical interpretation, especially in eyes that are smaller or larger than the 24 mm. schematic eye. Dr. Spackman's method is valuable in cases of this type, since it places the foreign body accurately in relation to Tenon's space. Since unnecessary sclerectomy is reprehensible, this new method should be employed in suitable cases.

DR. A. COWAN: The Sweet localization chart is based on the measurements of the schematic adult eye, 24 mm. in length. This means

that the 24 mm. is measured from the anterior surface of the cornea to the retina, so that allowance of about another millimeter should be made for the sclera. I do not know approximately how long the eye of an infant is, but it is so short that if it were not for the great strength of the dioptric system, there would be a great amount of hyperopia. An infant's eye is so much shorter than an adult's that this diagram could not possibly be used to localize a foreign body in young children.

The refractive error should also be taken into consideration, about 3 diopters being allowed for each millimeter in length. Allowances should always be made for certain cases when the Sweet system is used, which is based on a distance of 24 mm. from the anterior surface of the cornea to the posterior surface of the sclera.

DR. F. H. ADLER: I wish to express my thanks to Dr. Spackman for bringing this valuable test to our attention. In the two cases in which the test was of value, x-ray plates showed a foreign body in the neighborhood of the posterior half of the globe, either in or just posterior to the sclera. In one case the visual acuity was 6/22. An attempt to extract the foreign body would certainly have led to further visual loss. There was no response to the magnet, and it was a puzzling question whether to leave the foreign body in place or to attempt its removal. An injection of air showed the foreign body to be back of the sclera, and decided the issue. The eye was left alone, and when the patient was last seen, the condition was quiet. A traumatic cataract, which had developed subsequently, had reduced the vision to light perception. A light field and projection were good.

It is true that not many cases necessitate the differential test, but in a few cases it proves valuable.

DR. WILLIAM ZENTMAYER: I should like to ask whether there was a subconjunctival hemorrhage in any of the three cases reported. This is not apropos of roentgen localization, but the occurrence of subconjunctival hemorrhage in cases of injury by a foreign body is said to be indicative of double perforation. I have observed this condition at times.

DR. H. MAXWELL LANGDON: I think that all of us have been in the disagreeable position of not knowing whether a foreign body was within or without the globe. As Dr. Reese has already said, we should consider it most reprehensible to open the eye for a foreign body that was in the orbit and not find it, but it is equally reprehensible sometimes not to open the eye.

I had an experience with a case in which Dr. Pancoast had localized the foreign body and felt positive that it was in the orbit, but there was a double perforation. An attempt was made to extract the foreign body, the external rectus muscle being resected; the globe was badly damaged. Permission had been obtained to enucleate the eye if the foreign body was not found. The reason for opening the orbit was that the eye was inflamed and seemed to be getting worse, and it was felt that it was better to remove the source of irritation, but the attempt failed. The globe was enucleated, and the foreign body was found within the globe, the eyeball in this case being much longer than the standard 24 mm.

ALLERGIC INVESTIGATIONS IN TWENTY-THREE CASES OF VERNAL CONJUNCTIVITIS. MISS IDA TELLER (by invitation).

The work presented was done in an effort to determine whether vernal conjunctivitis has an allergic etiology. Primarily, four points

were studied on which the decision was to be made: (1) the allergic history of the patient, that is, both the periodicity or return of symptoms at a given time of the year and the presence or absence of other allergic conditions; (2) the family history of allergy; (3) cutaneous tests to determine whether the patient was sensitive to foreign proteins, with a study of the relationship of any positive reactions to the occurrence of vernal conjunctivitis, and (4) the eosinophil count of the blood in the eye smear studied for eosinophils. A physical examination was also made on a number of the patients, with special reference to any endocrine dysfunction.

The results of the study showed that a normal number of patients gave a history of other allergic conditions, although an unusually large number, or 21 per cent, gave a family history of allergy.

The blood count for eosinophils was above normal in 35 per cent. An unusually large number, or eleven of twenty patients, had eye smears containing eosinophils.

Of the twenty-three patients studied, four, or 17 per cent, gave positive reactions to skin tests made by the scratch method, although in only two of these cases does it seem likely that the sensitivity as indicated by the skin test could be the cause of the vernal conjunctivitis.

VERNAL CONJUNCTIVITIS: OBSERVATIONS ON EIGHTY-SEVEN CASES AT THE WILLS HOSPITAL (1929-1931). DR. LOUIS LEHRFELD (by invitation).

This article was published in full in the September issue.

DISCUSSION

Some of the discussion on this paper appears in the September issue (page 401). Because not all of it was received in time for such inclusion, the complete discussion is given here.

DR. B. P. WIDMANN: Some observers have been so enthusiastic about the treatment with radium of vernal conjunctivitis that they hold this procedure as almost specific, particularly for the acute and subacute phases of the condition. Many of the patients with vernal conjunctivitis in whom there were good results were subject to seasonal recurrences. The radiologic department at Wills Hospital studied the questions of dosage, the tolerance of the ocular tissue and the end-results. Technical factors of filtration and the methods of applying radium, with special reference to establishing a minimum dose, time and frequency of application, were considered. The factors of dosage established at the Philadelphia General Hospital on the basis of vast experimental and clinical experiences were accepted as the working basis of treatment.

Filtration equivalent to 2 mm. of brass was used, and a plaque was made so that it would cover the entire surface of the eyelid. The treatments were given in quantities estimated at 25 per cent of a full dose, at weekly intervals for four treatments. A small group of patients was given treatment over a period of six weeks. Recurrent lesions were treated in a similar manner. A small group of patients was treated by inverting the eyelid and by placing the radium plaques immediately in contact with the conjunctiva. While the immediate effects of irradiation appeared to be satisfactory, the uniform tendency for recurrence of symptoms indicates that there must be a constitutional factor, probably allergic in character.

Twenty patients received treatment with radium at the Wills Hospital. The majority of these patients showed clinical regressions of the local pathologic condition. Either symptomatic comfort or complete relief was common. Practically all of the recurrent cases showed a seasonal recurrence of symptoms, equal to the distress at the start of treatment. It is significant to note that many of the patients showed no detectable evidence of local pathologic changes and no vestige of the original character of granulation tissue, but had symptoms of itchiness and pain, comparable if not worse than the symptoms at the onset of treatment. Only about 50 per cent of the patients with recurrent cases, who presented no detectable local pathologic changes, were relieved symptomatically by further treatment with radium.

It is hazardous to continue treatment with radium for successive recurrences, particularly because of the risk of obtaining cumulative effects of radium. These cumulative effects occur as the result of a diffuse endarteritis of the fine capillary blood vessels, terminating in a degree of fibrosis and hyalinization that interferes with circulation. Late degenerative changes as a result of such tissue alterations may occur within two years and even later.

DR. ALEXANDER CLARKE: There is a superficial and tantalizing similarity between hay fever and vernal conjunctivitis. Hay fever is a form of allergy in which treatment is most satisfactory, and if it can be proved that vernal conjunctivitis is also allergic in origin, it might be possible to develop a similar simple and satisfactory treatment.

Allergy is the study of the unusual reaction in contradistinction to the usual reaction. For example, the usual reaction to large doses of quinine is ringing in the ears and deafness. Such a reaction can be produced in any person. Urticaria is an unusual reaction to quinine and occurs only in sensitive persons. In order to prove that vernal conjunctivitis is an allergic or an unusual reaction to some harmless substance, such as pollen, it is necessary to discover and prove such substances beyond a doubt. At present this cannot be done.

The evidence in favor of vernal conjunctivitis as an allergic phenomenon lies in its similarity to hay fever. Both conditions occur in the summer, and both produce manifestations in the eyes. In the two conditions there are positive reactions of the skin to pollens, and in both other manifestations of allergy, such as asthma and eczema, are not infrequently seen. Eosinophils are present in the typical secretion in each condition. The evidence against vernal conjunctivitis as an allergy consists, first, in the absence of a family history of vernal conjunctivitis. Dr. Lehrfeld tells me that he has never seen two cases of vernal conjunctivitis in the same family. While there are positive reactions of the skin in both conditions, it is necessary to use a solution from 100 to 1,000 times stronger to get a reaction in vernal conjunctivitis than in hay fever. In hay fever the severity of the symptoms varies directly with the amount of pollen inhaled. The symptoms of vernal conjunctivitis, on the other hand, do not follow the pollinating periods, but are influenced more by temperature. A small number of persons suffering from vernal conjunctivitis have been given treatments for hay fever, much larger doses being used. The results seem to be worth continuing.

The pathologic change in hay fever is an urticarial swelling which can be cleared up entirely in a few minutes by the use of epinephrine, whereas the pathologic change in vernal conjunctivitis is a persistent granulation. In this respect vernal conjunctivitis seems to be more nearly related to eczema, an allergy characterized by a persistent inflammation. The methods of treating an allergy have helped little, if at all, in the treatment of eczema.

Such are the arguments in favor of and against considering vernal conjunctivitis as an allergy. They are not sufficient to make an unqualified decision. My opinion

is that vernal conjunctivitis is an allergy of the eczematous type, rather than of the urticaria or hay fever group.

Dr. George E. de Schweinitz: In regard to my experience with radium in the treatment of vernal conjunctivitis, I am satisfied with the therapeutic value of this agent, especially for the varieties of conjunctival disease with large ("cobble-stone") lesions, and I agree with the other observers, that the efficacy of radium is enhanced if, prior to its use, the surface of the grossly developed granulations is shaved off.

Complications may arise, for instance, loss of the eyelashes and cataract. Although corneal involvement is uncommon, it does occur, and may be prevented by the use of radium.

Some years ago, Dr. Shumway published a small series of cases, some from his own clinic, in which there were excellent results, and in no case, so far as he knew, did cataract develop.

I was interested in Dr. Clarke's comments on treatment with radium, and think it most important, as Dr. Clarke pointed out, that radium therapy, although useful, does not prevent recurrences, and that the repeated use of this agent may produce the complications to which reference has been made. I have seen one patient in consultation in whom cataract formed after treatment with radium, but the type of cataract was not that which is characteristic of the radiational variety, which I discussed at some length at a previous meeting of the Section, especially after the destruction of epibulbar sarcomas.

I have often used epinephrine in a boric acid solution to relieve the intense irritation and itching, a lotion commonly employed in this disease. A change of the patient from one climate to another was sometimes followed by astonishingly good results, much as in the cases of patients with hay fever.

Dr. T. B. Holloway: I have found a fibrin ferment the most satisfactory of any of the drugs that have been suggested for the relief of symptoms in vernal catarrh.

Dr. Louis Lehrfeld: In my attempt to shorten my paper I failed to mention the use of epinephrine in combination with phenacaine—4 grains (0.26 Gm.) of phenacaine and 30 minims (1.9 cc.) of epinephrine to an ounce (30 cc.) of water. This mixture is used three times a day, particularly at bed time, when the itching seems to become intense and when the patients derive the greatest comfort from its use.

I also mentioned the shaving or the removal of the granules on the lid in my paper. In one case, the granules were removed from one eye and the fellow eye was treated by radium. The results, which were excellent, were similar in both eyes.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

Annual Congress, May 12, 13 and 14, 1932

A. H. H. Sinclair, M.D., *President, in the Chair*

Ocular Tuberculosis. Dr. Josef Urbanek.

For a long time tuberculosis was not accepted as a causative agent in diseases of the eye because physicians reported that no tuberculosis was found in the lungs. Yet the lungs are not normal in patients having

uveitis and other inflammatory ocular diseases, as is revealed by roentgen examination. The forms of proliferating tuberculosis most frequently found in ocular diseases show the mildest and the fewest symptoms and signs; in those cases the tubercle bacilli seem to lack the ability to produce the typical granulation tissue with central caseation or even typical giant cell formation. The only sound method of specific diagnosis consists of the injection of one of the tuberculin preparations intradermically, and the noting of whether the patient shows an allergic reaction from the tuberculin antigen. The inflammatory reaction is awaited two days later. These injections are preceded by one of 0.2 cc. of a 0.25 per cent phenol solution. About 100 adult patients with keratoconjunctivitis scrofulosa have been tested in this way, and a majority reacted positively. All the patients were given a course of tuberculin. That tuberculosis plays an important rôle in the etiology of episcleritis and sclerosing keratitis is shown by the finding of tubercle bacilli in the blood stream.

Tryparsamide in Treatment of Syphilitic Optic Atrophy. Mr. David Lees.

My associates and I at the Venereal Disease Clinic of the Royal Infirmary have treated forty-eight patients with optic atrophy due to syphilis, and have found that tryparsamide used in the correct dosages checked the atrophy and that the patient continued ambulant and remained at his occupation. Often an apparently unsuccessful case takes a hopeful turn when bismuth is used in association with the tryparsamide.

Syphilitic Tarsitis. Mr. Maurice Whiting.

The patient, a single woman aged 20, entered the hospital with the complaint of a swelling of the lower left lid, the size of a hazel nut; there was also a general thickening of the tarsal plate. The conjunctiva was pale and waxy looking and seemed to be more closely adherent to the deep surface of the swelling than to the normal tarsal plate. There was no pain, tenderness or glandular enlargement. My diagnosis in the case was arrived at only by a process of exclusion. Though the Wassermann test was negative, I felt sure that the case was syphilitic, and so I began treatment with neoarsphenamine; after the second injection the swellings became only half their former size, and a little later, before the patient left for a holiday, three of the swellings had partly disappeared.

Dacryocystorhinostomy. Dr. H. M. Traquair.

The aim in the treatment of chronic dacryocystitis is a restoration of normal conditions, but no method has been successful in doing this; so it seems that at present the ophthalmic surgeon must be content with securing the permanent comfort and contentment of the patient. There are two satisfactory methods: (1) excision of the sac and (2) drainage into the nose. Though probing and syringing sometimes do good in the early stages, I think them quite unreliable, as the patients return sooner or later with the disease more advanced. Patients hold different views as to what constitutes a satisfactory result, but their feelings are the only criterion as to whether the operation is regarded as successful.

Meller, who strongly advocates excision, says that after extirpation of the sac, correctly carried out, most patients complain little or not at all of lacrimation, and are as good as freed from their trouble. In my clinic in the last three years, 161 patients have been operated on for dacryocystitis, and 53 excisions of the sac have been done. Toti's operation was done in 113 cases (14 times on both sides, or 127 external dacryocystorhinostomies), and of 117 of these patients who replied to an inquiry as to their condition, 71 per cent said that there was no watering. Of 48 excisions no watering was reported in 21, or 44 per cent.

Unless the patient is a young child I always use local anesthesia. My solution is procaine hydrochloride 1.5 Gm., cocaine 0.5 Gm. and physiologic solution of sodium chloride to make 100 Gm. Before use, epinephrine is added sufficient to bring the strength up to 2 per cent. I make the incision immediately under the internal palpebral ligament, about 3 mm. internal to the canthus. If, in the course of the operation, there is found to be oozing of blood, or sensitivity on the part of the patient, the cavity is swabbed with the cocaine-epinephrine solution.

The only complication that I have experienced is postoperative hemorrhage. In two cases there were fairly severe attacks of epistaxis, but, beyond delaying discharge from the hospital, there were no harmful effects. The final results cannot be estimated until several weeks after the operation. Nine years was the age of the youngest patient. and 78 that of the oldest.

SENILE CATARACT: PREOPERATIVE AND POSTOPERATIVE MANAGEMENT AND COMPLICATIONS. DR. A. J. BALLANTYNE.

Published figures make clear the fact that all standard operations for this purpose are able to produce long series of first class results. One does not find the same triumphs from asepsis and antisepsis in operations on the eye as in general surgery; infections of the wound, of the iris and of the ciliary body are still some of the most serious complications, though wound infection is now less frequent than it was thirty years ago. Infection of the wound may not be evident until seventy-two hours after the operation. The endogenous infective factor may take the form of gastro-intestinal toxins, toxic products of tissue metabolism, toxins of bacteria or micro-organisms themselves. Exogenous infection is of paramount importance, even in the case of low grade intra-ocular inflammations.

As to prophylactic asepsis, the ophthalmic surgeon does better without rubber gloves, as these hamper the finer movements and dull the sensitivity of the fingers. But I strongly favor the wearing of a mask to cover the nose and mouth by both the operator and assistants. Admittedly the lashes, conjunctiva and other parts of the eye cannot be completely sterilized, though much can be done to minimize the risk of sepsis. The danger of dacryocystis can be obviated by excising the sac, ligaturing the canaliculi or cauterizing the puncta before the intra-ocular operation is considered. I always have a culture made from the eye two days before the operation, and the eye is cleaned twice daily by irrigation with physiologic solution of sodium chloride, followed by the instillation of drops of acriflavine hydrochloride of a strength of 1:1,000. Should the eye be clean on the day chosen for the operation, a final application of lotion and drops is made while the patient is on

the table. But if there is still an abundance of cocci, the operation is postponed, and the preparatory treatment is continued, supplemented by the instillation of drops of 1 per cent mercurochrome-220 soluble. I have found acriflavine hydrochloride valuable. Some operators use 2 per cent yellow oxide of mercury ointment, which, it has been claimed, produces complete sterility of the conjunctival sac in 90 per cent of cases. Apparently the pneumococcus is the ophthalmologist's chief enemy.

It is my practice to give a purgative a day or two before operation. I should like to see a more thorough routine investigation made in these cases with regard to the functions of the bowel, kidney and other organs, as this may reveal conditions which should be rectified before operation. Surgeons as a whole still hold to the traditional fear of diabetes, which at one time was thought to be an absolute bar to operation, because, in the main, these patients show a tendency to bleed, and their tissue heals badly and slowly. Should signs of hyperglycemia appear after the cataract extraction, insulin should be given without delay, and the urine should be examined at short intervals. It is now possible to prevent the onset of diabetic coma after the operation.

Albuminuria is not, in itself, a bar to operation, but it may point to the existence of cardiovascular or renal disease, and these conditions increase the operative risk.

The possibility of sympathetic inflammation of the other eye is important, though my own experience includes only two instances of it.

Another postoperative complication is glaucoma, of which I have met 4 cases in 100 in which operations were performed, in nursing homes. The interval before this supervenes may be of any length, even twenty years. Apparently the best results follow iridectomy and sclerocorneal trephining, the latter being done at the angle of the anterior chamber opposite the original wound.

DISCUSSION

SIR ARNOLD LAWSON: I regard most of the antiseptic washings of the eye and the precautions against contamination usually adopted as unnecessary, and even irritative, as in the normal way the conjunctiva is clean. I have injected cultures of Bacillus xerosis and Staphylococcus albus and citreus into the rabbit's conjunctiva, always with negative results. All that is necessary is to exclude before operation the presence of a conjunctival discharge, for there is always a discharge when a dangerous organism is present in the eye. In none of my private cases has there been intra-ocular suppuration. As most operations for cataract are done on persons past middle life, every effort should be made to have the patient in the best possible health. It is important to procure a complete dilation of the pupil as soon as possible after the conclusion of the operation.

SIR RICHARD CRUISE: It is important to secure the patient's confidence. I always give a sedative before operating, and if there seems to be any danger of hemorrhage I give hemostatic serum a few hours before. After operation, the great aim should be to keep the patient as quiet as possible.

DR. H. M. TRAQUAIR: Mental derangement occurs occasionally following cataract extraction.

MR. R. FOSTER MOORE: The Barraquer method of operation for cataract is subject to criticism because of the frequency with which it results in loss of vitreous. No doubt this loss is sometimes attributable to lack of sufficient skill on the surgeon's part, but the patient's behavior is important too, and over that the surgeon has little or no control. When loss of vitreous occurs, it is necessary that the lens be removed from the eye, at whatever stage of the operation the loss occurs. Then, one should see that the conjunctival flap is replaced over the wound, and not left turned down over the cornea. All vitreous must be conserved. I think that eyes are sometimes spoiled by an unwillingness on the surgeon's part to leave an eye with iris in the wound and by a too protracted attempt to overcome this at the time of its occurrence.

INTRACRANIAL RESECTION OF THE OPTIC NERVE IN RETINOBLASTOMA. MR. NORMAN M. DOTT and MR. SPENCE MEIGHAN.

Dr. A. B. Reese, of New York, stated that relatively modern statistics show that of eyes removed for retinoblastoma, 52 per cent showed invasion of the optic nerve, and 81 per cent of these invaded nerves showed that severance of the nerve at enucleation was distal to the disease extension. So 43 per cent of all cases of enucleation are doomed to failure before the patient leaves the operating room. Yet retinoblastoma is a tumor that remains for a long time confined by the fibrous walls of the eyeball and optic nerve, showing little tendency to invade tissues other than its parent nerve tissue. Death results from a backward invasion to the optic chiasm and brain, not from local spread or from glandular or blood stream metastasis.

The patient was presented because of the peculiar appearance of the pupil of the left eye and some associated discomfort. A whitish appearance of the pupil had been noted six months previously, and subsequently there had been associated pain. The anterior chamber was shallow, and the eyeball seemed to be filled with a whitish nodular mass, on the surface of which coursed a few small vessels. There was no proptosis or glandular enlargement. The right eye was healthy. The obvious diagnosis of retinoblastoma was made, and enucleation was advised; this was done in October, 1931. The optic nerve was severed with the globe still in the orbital cavity. Eventually canthotomy had to be carried out in order to extract the detached eye. The sclera was intact, and the tumor filled the eye completely.

Seven days after the enucleation the orbit was reopened, and an attempt was made to secure a further portion of the remaining nerve at the apex of the orbit. Fourteen days after enucleation, in a further attempt to arrest the disease, a radium bomb was directed on the orbit for two forty-eight hour periods. But, in view of the bad prognosis in these cases, it was felt that the occasion demanded intracranial resection of the optic nerve. The entire length of the optic nerve was removed up to the optic chiasm. The operative area became infected, but later this subsided, and the child's health has since been excellent.

Book Reviews

Die intrakapsulare Starextraktion. By Prof. A. Elschnig, Prague. Price, 6.90 marks. Pp. 71, with 26 illustrations. Berlin: Julius Springer, 1932.

Elschnig states that not only is intracapsular extraction the ideal cataract operation, but its technic has become so perfected that its adoption should be general. To fulfil the latter purpose, all of the present experiences with the intracapsular method are collected. In a historical survey the author states that it was Henry Smith who originated this operation, which was then further developed by others until the present accepted method was found, which consists principally in the use of the blunt capsule forceps. Elschnig has combined some details of the Barraquer method with a modified Knapp-Török procedure and has now applied this method in 1,500 cases, and is convinced of its simplicity and safety.

This intracapsular operation he calls the Knapp-Török-Elschnig. The preparations for the operation remain the same as for the usual cataract extraction. The akinesia is obtained by the Van Lint-Rochat technic, and the much better O'Brien method is not mentioned. After a retrobulbar injection and a suture through the superior rectus muscle, the operation is proceeded with. A suture is applied to the conjunctiva after the section; then the iris root is incised with de Wecker scissors; the cataract is subluxated with forceps, which Elschnig states are modeled after those of Stanculeanu. To my mind they are much more like Kalt forceps, except that the branches are more oblique to the shaft. Stanculeanu used the forceps of Manolescu, which are practically iris forceps with a blunt end applying the convex or reverse curve of the branches to the capsule. The forceps grasp the capsule at the lower pupillary margin, and then with gentle lateral movement and pressure with the tenotomy hook at the lower limbus straight back, the cataract is dislocated below. Traction with the forceps in contact with the capsule is exerted upward; the lens tumbles and is extracted with the aid of the hook pressing on the cornea. It is gratifying to see that Professor Elschnig appreciates the value of the tumbling maneuver. But to do this with the capsule forceps gripping the capusle must cause undue traction on the capsule, as the forceps must follow the excursion of the cataract, and this traction is likely to be followed by a rupture of the capsule in a greater proportion of cases than when the capsule forceps are removed as soon as the subluxation has taken place, as the reviewer has always emphasized. After delivery of the lens, the conjunctival suture is tied, the iris is smoothed out, 5 per cent iodine solution is applied to the conjunctival wound, 1 per cent physostigmine (eserine) is instilled, and a dressing is applied.

Intracapsular extraction with iridectomy is then described. Curiously enough, Elschnig states that in this method it is immaterial whether the cataract is extracted head on or by tumbling. With this the reviewer does not agree; experience has shown that tumbling is by far the safer

method and should be the only one considered by the general operator. Under complications during the operation, the author speaks of conjunctival suture, which he believes to be essential, of blood in the anterior chamber, of the slipping off of the capsule forceps in grasping the capsule, of the collapse of the eyeball and of loss of vitreous. The reviewer has found that when the capsule forceps will not take hold of the capsule, they will do so if the blades are applied to the capsule at a more acute angle, though this is followed by a greater percentage of ruptured capsules. Among the disturbances in healing, the author mentions slow closure of the anterior chamber, iritis, iris prolapse, glaucoma and retinal detachment.

Then follows a description of the intracapsular extraction of Pagenstecher, Henry Smith and Barraquer. Under extraction with the use of the blunt capsule forceps, the author speaks of the methods of Stanculeanu and of A. Knapp and their modification by Török and by others. The advantages of the intracapsular operation and its indications are then taken up. The tumescent, the morgagnian and the tetanic cataracts are not suited for this operation. The author does not hesitate to operate intracapsularly in exophthalmos and high myopia, for the removal of a clear lens in high myopia and in keratoconus. Cyclitic cataracts are particularly easy to extract in the capsule, unless there is a flat adhesion between the iris and the capsule of the lens. In subluxation of the lens, the author likes to apply the Liégard suture before making the corneal incision.

Interesting statistics conclude the monograph. From January, 1926, to June, 1931, 1,522 operations for cataract were performed: 1,221 simple and 301 combined. Extraction in the capsule succeeded in 65 per cent, loss of vitreous occurred in 3.48 per cent; iris prolapse occurred in 2.69 per cent; there were 2 expulsive hemorrhages, 5 wound infections, no instances of severe iridocyclitis and 15 cases of mild iritis.

This description of the intracapsular cataract operation is most timely, as it brings the experience of an exceptionally skilful operator who has carefully studied every phase of this problem. The method described is the only safe method of intracapsular operation which is known at the present day. Its presentation should create renewed interest in this operation and facilitate the determination of its place in ophthalmic surgery.

A. K.

A Survey of Sight-Saving Classes in the Public Schools of the United States. By Edward T. Myers, Ph.D. Price $0.50. Pp. 105. Publication No. 64. New York: National Society for the Prevention of Blindness.

This survey, conducted largely through questionnaires, sought to gather facts about the present status of sight-saving classes in the United States. Modeled after a "myope class" founded in London in 1908, the first sight-saving class in the United States was established at Boston in 1913. By the end of 1928, in the United States there were 319 such classes, attended by 4,465 pupils (averaging 14 to the class), in 87 communities in 21 states. Classes were lacking in the remaining 27 states and in the District of Columbia. The ideal ratio, providing special instruction for one handicapped child for each thousand of

school population, has not been attained. With the possible exception of Ohio, the greatest deficiency in instruction of this type has been found in communities of less than 30,000 population and in rural communities.

In the selection of children suitable for instruction in sight-saving classes, nominations made by parents, school authorities and social agencies should be passed on by an ophthalmologist after adequate examination of the eyes. Instruction in the sight-saving class utilizes both eye and ear as portals of entry to the sensorium, placing more emphasis on the ear and less on the eye than in the usual school curriculum. Unsuitable candidates are those of subnormal mentality, deafmutes and children having less than 20/200 acuity in the better eye. Suitable candidates are those with useful hearing, with an established normal mentality and with a corrected visual acuity of 20/50 in the better eye. Myopia of more than 4 diopters, particularly if progressive, indicates admission to the class, even if the acuity reaches the normal level.

A study of enrollments in sight-saving classes in the United States revealed the following percentages: 50.2 boys and 49.8 girls; 91.2 white, 8.2 Negro and 0.6 mongolian; myopia comprised 38.9 of the total. Of all enrolled children who could profit by the use of glasses, only 4.3 per cent were not supplied with them. Reduced visual acuity at the second test was reported in 9.4 per cent of the 1,751 children so tested, but no statement is made whether the loss was due to myopia or to other causes. No reliable conclusion can be drawn as to the mentality of the enrolled children, because the intelligence quotients showed a distribution considerably below normal, while the teachers' estimates of mentality based on class work showed a distribution above normal. Low mentality is in itself a greater handicap in the education of the child than is poor vision. Sixty per cent of the enrolled children were entered in grades 3, 4, 5 and 6 and the remainder in other grades from kindergarten to the twelfth. The interested reader should consult the original monograph with its statistical tables, which do not permit of detailed review.

The teacher of the sight-saving class was found to be a graduate of either college or normal school, with postgraduate training in the special methods of the sight-saving class. Many teachers had previous experience in public school teaching before entering the special field. The median length of experience in grade teaching was found to be nine and eight-tenths years, and in sight-saving class instruction, two and eight-tenths years.

Postgraduate instruction in the special methods of instruction was obtained at the following institutions: University of Chicago, University of Cincinnati, Cleveland School of Education, Columbia University, Detroit Teachers College, Harvard University, New York University, Peabody College, Perkins Institute, University of Pennsylvania, University of Southern California and Western Reserve University.

Practical training in the methods was obtained in the following communities: Boston, Grand Rapids, Minneapolis and Los Angeles.

J. HERBERT WAITE.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217, Faubourg St. Honoré, Paris.
Secretary-General pro tem: Dr. A. Churchill, 66, Boulevard St. Michel, Paris.

International Ophthalmologic Congress

Secretary: Dr. Franciso Poyales, Olozaga 3, Madrid, Spain.
Place: Madrid, Spain. Time, April 16-22, 1933.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Sir J. Herbert Parsons, 54 Queen Anne St., Cavendish Square, London, W. I.

Ophthalmological Society of the United Kingdom

President: Mr. A. H. H. Sinclair, 6 Charlotte Square, Edinburgh.
Secretary: Mr. Humphrey Neame, 56 Portland Place, London, W. I.

Oxford Ophthalmological Congress

Master: Dr. Cyril Walker, Bristol, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. E. W. Brewerton, 73 Harley St., W. 1, London.
Secretary: Dr. P. G. Doyne, 60 Queen Anne St., W. 1, London.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.

NATIONAL

American Medical Association, Section on Ophthalmology

Chairman: Dr. Frederick H. Verhoeff, 82 Commonwealth Ave., Boston.
Secretary: Dr. Parker Heath, 1551 Woodward Ave., Detroit.
Place: Milwaukee. Time: June 12-16, 1933.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal, Canada.
President-Elect: Dr. B. R. Shurley, 62 W. Adams Ave., Detroit.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.

American Ophthalmological Society

President: Dr. Thomas B. Holloway, 1819 Chestnut St., Philadelphia.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.
Place: Washington, D. C. Time: May 8-10, 1933.

SECTIONAL

New England Ophthalmological Society

President: Dr. David W. Wells, Hotel Westminster, Boston.
Secretary-Treasurer: Dr. Theodore L. Terry, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Hans Barkan, 490 Post St., San Francisco.
Secretary-Treasurer: Dr. J. Frank Friesen, 1208 Roosevelt Bldg., Los Angeles.
Place: San Francisco. Time: 1933.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John H. Harter, 1215 Fourth Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, 806 Cobb Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. R. B. Smith, Alma, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: First Friday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. John B. Gregg, 101 S. Main St., Sioux Falls, S. Dakota.
Secretary-Treasurer: Dr. F. H. Roost, 420 Trimble Bldg., Sioux City, Iowa.
Place: Sioux City, Iowa. Time: November, 1932.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Wiley R. Buffington, 211 Camp St., New Orleans.
Secretary: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: Birmingham, Ala. Time: November, 1932.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. W. E. McGarvey, 802 Jackson City Bank Bldg., Jackson.
Secretary: Dr. Don C. Lyons, 1405 Union and Peoples National Bank Bldg., Jackson.
Time: Third Thursday of alternate months.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Ralph W. Danielson, 258 Metropolitan Bldg., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. M. H. Gill, 36 Pearl St., Hartford.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. Thomas H. Hall, Jr., 617 Mulberry St., Macon.
Secretary-Treasurer: Dr. J. A. Smith, 700 Spring St., Macon.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. R. Gillum, 221 S. Sixth St., Terre Haute.
Secretary: Dr. J. Kent Leasure, 23 E. Ohio St., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. W. W. Pearson, 410 Sixth Ave., Des Moines.
Secretary-Treasurer: Dr. W. F. Boiler, 105 E. Iowa Ave., Iowa City.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Wilfred Haughey, 303 Post Bldg., Battle Creek.
Secretary: Dr. H. O. Westervelt, 239 Pipestone St., Benton Harbor.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Harold J. Rothschild, 239 Lowry Bldg., St. Paul.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. L. H. Huber, Livingston.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Charles H. Schlichter, 556 N. Broad St., Elizabeth.
Secretary: Dr. B. E. Failing, 31 Lincoln Park, Newark.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. D. F. Gillette, 109 S. Warren St., Syracuse.
Secretary: Dr. Frank M. Sulzman, 1831 Fifth Ave., Troy.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Axel Oftedal, 55½ Broadway, Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 516 Fourth St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Herman A. Winkler, 224 Thayer St., Providence.
Secretary: Dr. N. A. Bolotow, 108 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. B. McWhorter, 106 E. Earle St., Anderson.
Secretary-Treasurer: Dr. G. M. Truluck, Orangeburg.
Time: April and December.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. W. D. Jones, 3116 Live Oak St., Dallas, Texas.
Secretary: Dr. A. F. Clark, 1034 Nix Professional Bldg., San Antonio.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. D. W. Henderson, 75 S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. T. F. Welch, 14 Exchange Pl., Salt Lake City.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Frank P. Swart, 142 W. York St., Norfolk.
Secretary-Treasurer: Dr. H. G. Preston, 307 Professional Bldg., Harrisonburg.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. O. H. Bobbitt, Medical Arts Bldg., Charleston.
Secretary: Dr. Harry V. Thomas, 95 Fairmont Ave., Fairmont.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Elbert A. Curtis, 65 Central St., Newark.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

Academy of Medicine of Toronto, Section of Ophthalmology

Chairman: Dr. P. J. F. Houston, 34 Hurndale Ave., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W., Toronto.
Time: First Monday of winter months.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. L. C. Rouglin, 127 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Harry Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. William M. Rowland, 906 Cathedral St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. W. F. C. Steinbugler, 515 Ocean Ave., Brooklyn.
Secretary: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. H. D. Andrews, 33 Allen St., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Michael Goldenburg, 104 S. Michigan Ave., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. M. W. Jacoby, 2323 Prospect Ave., Cleveland.
Secretary: Dr. H. C. Rosenberger, 1065 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. Roy B. Metz, Hanna Bldg., Cleveland.
Secretary: Dr. Paul G. Moore, Medical Arts Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. L. F. Appleman, 308 S. Sixteenth St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. John B. Alcorn, 167 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Edward W. Harris, 681 E. Broad St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. O. M. Marchman, 1717 Pacific Ave., Dallas, Texas.
Recording Secretary: Dr. W. Mood Knowles, 1717 Pacific Ave., Dallas, Texas.
Corresponding Secretary: Dr. J. M. Potts, 1717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. Cecil C. Jones, 1121 Equitable Bldg., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. R. H. Seeley, 9 Court St., Rutland, Vt.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. R. H. Needham, 1304 Medical Arts Bldg., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1011 Medical Arts Bldg., Fort Worth.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Carl F. Snapp, 26 Sheldon Ave., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Walter W. Oliver, 26 Sheldon Ave., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. L. W. Raney, 609 Fannin St., Houston, Texas.
Secretary: Dr. J. F. Gamble, 201 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. John W. Carmack, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Albert N. Lemoine, 906 Grand Ave. ,Kansas City, Mo.
Secretary: Dr. Harold B. Hedrick, 618 Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

President: Dr. Ferris L. Arnold, 923 Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Clyde E. Harner, 312 Security Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from September to June.

Los Angeles County Medical Society, Section on Ophthalmology and Oto-Laryngology

President: Dr. J. Frank Friesen, 1208 Roosevelt Bldg., Los Angeles.
Secretary-Treasurer: Dr. F. H. Brandt, 1052 W. Sixth St., Los Angeles.
Place: Mary Louise Cafe. Time: 6:30 p. m., fourth Monday of each month from October to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. Albert P. Tibbets, 1801 I St., Washington.
Secretary Dr. G. Victor Simpson, Rhode Island Ave., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Oto-Laryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month. Annual meeting, Jan. 10, 1933.

Milwaukee Oto-Ophthalmic Society

President: Dr. T. F. McCormick, 324 Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 324 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

Montreal Ophthalmological Society

President: Dr. J. P. E. Bousquet, 66 Sherbrooke St., West, Montreal, Canada.
Secretary: Dr. J. A. MacMillan, 1410 Stanley St., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Hilliard Wood, 700 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. H. C. Smith, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. Charles A. Bahn, 150 Baronne St., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Algernon B. Reese, 73 E. Seventy-First St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. L. G. Howard, 532 First Ave., Council Bluffs, Iowa.
Secretary-Treasurer: Dr. W. A. Cassidy, 1620 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. William R. Weisiger, Medical Arts Bldg., Richmond, Va.
Secretary: Dr. R. W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. E. S. Amsler, 53 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. E. W. O'Brien, 5 N. Goodman St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Julius H. Gross, Carleton Bldg., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Charles J. Boehs, Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Robert C. Martin, 384 Post St., San Francisco.
Secretary: Dr. George N. Hosford, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Third Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. J. L. Scales, Medical Arts Bldg., Shreveport, La.
Secretary-Treasurer: Dr. W. L. Atkins, 505 Medical Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of each month from October to June.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. David Hartin, Old National Bank Bldg., Spokane, Wash.
Secretary: Dr. W. W. Henderson, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. W. G. Dickinson, 504 State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. Harold H. Joy, 504 State Tower Bldg., Syracuse, N. Y. N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

Tulsa Academy of Ophthalmology and Otolaryngology

President: Dr. Roy Dunlap, 108 W. Sixth St., Tulsa, Okla.
Secretary-Treasurer: Dr. Marvin D. Henley, 108 W. Sixth St., Tulsa, Okla.
Place: Medical Arts Bldg. Time: Monthly.